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PRODUCTION ENGINEERING ABSTRACTS... CXVIII

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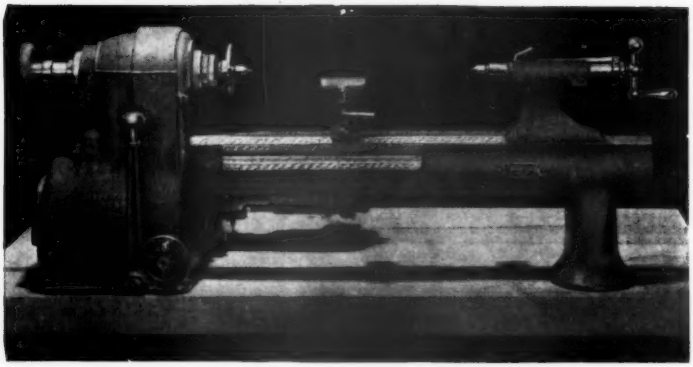

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THE GRADUATE AND MANAGEMENT

Paper presented to the Institution, Birmingham Section, by E. W. Hancock, Member of Council.

THE title of this paper has already been settled by the Papers Committee, in conjunction with a scheme which was devised by this Committee three years ago. A series of papers has already been given covering the first two sections of the group, namely :—

(1) WHAT THE GRADUATE SHOULD KNOW—one paper given by Mr. J. W. Berry, ref. August Journal, 1937 ; another paper by Dr. Anderson, ref. July Journal, 1937 ; another by Mr. J. Loxham, also in the July Journal, 1937.

(2) THE GRADUATE'S PLACE IN INDUSTRY—by Mr. R. H. Youngash, in the March Journal, 1938.

The object which the Papers Committee had in mind in recommending this group of papers to the Council was to be as instructive and helpful as possible to the younger members, both directly and indirectly. The more direct use is, of course, giving the benefit of the experience of senior members, and the opportunity to the graduate to speak freely in the discussions on these subjects which so directly concern him. The indirect assistance to which I refer will come as a result of discussing these subjects at an open meeting, thereby drawing the attention of individuals who are in control of production activities.

A great deal of credit for this series of papers goes to Mr. W. Groocock, who, like all members of the Council, is keenly interested in the graduate membership, as it is upon the successful training and instruction of the graduate members that the future of such an Institution as this depends.

Those who have not read the previous papers are advised to do so, as whilst this type of paper cannot give very specific and detailed information, it can give broad outlines, which often are much more useful in stimulating inquiry and interest. The previous papers, therefore, give a background leading to the more definite period when a graduate commences to earn his living, and begins to undertake some position of responsibility.

In an address which I gave last session, to both the graduates of this Institution in Coventry and the graduates of the Institution

of Automobile Engineers in Coventry and Birmingham, a background is given on the subject of vocational guidance, but the subject with which I am dealing in this paper takes perhaps a more definite form, as reference will be made to the earlier stages of application of training. Without the management's interest in the graduate, the important connecting link between training and occupation may be somewhat haphazard, and is very often only joined by chance.

Is the Management Interested in the Graduate ?

The obvious and usual reply is, of course, "yes," but whether this interest takes a definite and practical form is a subject worthy of discussion. Viewing this question from the management's point of view, and free from any personal sympathies or tendencies, there is firstly and very definitely always the inevitable question of replacement, dictated in no uncertain way by nature. One generation following another is as certain as life and death, and whatever may be the personal views of individual managers, it is a fact that replacements must be continually made.

This aspect, whilst appearing to be somewhat callous, is a fundamental fact, and therefore must always be under consideration by the management. When the question of replacement is being reviewed, the question must inevitably arise—with what ? When, for example, a machine tool needs replacing, on account of age, it is very rarely that this machine is replaced by a new one of identically the same design, as in the passing of the years between the old and the new progress has been made.

Precisely the same parallel can be drawn with the human machine, and the new replacement should therefore have made the correct degree of progress, in order that the standards at that time are at least maintained. Consequently, one cannot place too much importance on the question of earlier training, with the educational authorities fully alive to the needs of industry, so that the younger men are being properly trained towards that end.

This is particularly important in connection with production engineering, as apart from the fact that this represents the greatest need of the country to-day, it has in itself made such progress over the years that new standards and combinations of subjects are necessary to give the correct background training and degrees of knowledge. This question of replacement, therefore, indicates the first fundamental reason for the management's interest, and the next stage of investigation needs some study.

We have knowledge that, right through the ages, nations rise and fall. We equally have knowledge that, in industry, manufacturing businesses similarly rise and fall. This subject will bear closer study, as when one refers to a business one is not really

referring to the office building, the works building, the machine tools in that building, etc., but chiefly to the men who control and manage that business, as the buildings, plant and equipment are only the result of the activities of the men in control.

History shows that it is the human beings in control, backed by their fellows, who really make a nation. Dependent entirely upon how those human beings control, dictate or advise, so that nation holds its position with others. This equally applies to any business concern. Whether a business be successful or on the decline, the demand for progress is constant. Whether the objective is to retain a success or build up from a failure, the atmosphere of progressive thought must always be present if the normal objective of any commercial undertaking is to be maintained.

Much can be said regarding the detrimental effect of a lethargic outlook, whether it be in a business concern or in a nation, but progress, if only spurred on by competition, must be ever present. The management, therefore, in considering the employment of young men, is of necessity interested in those young men being progressive. To be progressive does not mean to be merely ambitious, but in the engineering world must depend upon study and then application. This then will indicate a further reason for the management's interest in the graduate, as it is an indication of the graduate's progressive outlook for him to be associated with a progressive Institution such as this.

Another reason why the management is interested in the graduate is because senior members of any profession, who have themselves worked very hard from their youth and in the process have helped with the development and progress of any craft or profession, are naturally interested in seeing that the work is carried on.

This carries with it an element of sentiment, as most senior men in any profession believe that it is good not only for their particular profession, but also for the nation, for proper development work to be carried on, and the majority are only too anxious and willing to hand over the reins to younger men, providing the correct degree of competence and interest is displayed by those young men.

Under this heading—*is the management interested in the graduate* ? I want to stimulate inquiries as to how management does, in a practical form, demonstrate its interest.

(*Mr. Hancock then gave a broad outline of an apprentice and pupil training scheme with which he was associated*).

Can the Graduate Help the Manager ?

I refer now chiefly to works management, and the many and varied functions which come under that heading. The works

manager may be likened to the captain of a ship (however large or small), having not only the crew and the ship to look after, but also the surrounding sea with which to contend, with all its perils and dangers.

There is hardly a phase of the commercial, technical or psychological aspects of business which does not have to be dealt with at some time or another by works management. It is not only knowing *what* to do but *how* it should be done, and this in turn depends upon experience. Experience depends very largely on what one learns from others, and what one learns from others again depends a great deal upon one's character and honesty of purpose. A genuine desire to learn, with an honest purpose, usually draws the best instruction, and in consequence a manager is more interested in a young man who shows these tendencies. Whilst education of the knowledge-acquiring type is useful, and forms a good basis, a pleasing personality and a genuine character are necessary lubricants to an individual's wheels of progress.

Since human beings provide the real motive power to a business, it is of little use to acquire an abundance of knowledge without acquiring the ability to apply or impart that knowledge. A graduate, if he is to help the management, should develop as early as possible the ability to apply and impart his daily acquired knowledge, because this is an essential part of an individual's progress in any way associated with production engineering.

The individual's progress in business depends to some extent upon his ability to control, guide and instruct others, not just by power of position, but by sound and reasonable application. It is difficult to depute work by instruction to others unless one has acquired knowledge by actual experience. There is no question that the graduate can be of considerable help to management, providing he approaches his duties in the right spirit, endeavouring at all times to absorb information already available, as by so doing he fertilizes the soil in which the seeds of progress grow.

Managing to-day is not a matter of driving, as to achieve the desired result power alone is useless. Controlling a collection of human beings, comprising staff and operatives, each having his own separate problems and make-up, needs other than force to piece together and to co-relate the results of their labours. Each duty, each function, each unit of energy, both mental and physical, must join together as the hours, days and weeks go by, and yield some useful product to the country. If, therefore, my previous observations are accepted, namely that human beings are the prime movers, it will be appreciated that emphasis must be laid on the importance of organising their activities in such a way that the best and most efficient results are obtained.

The manager is constantly appreciating that many thousands of

people are dependent upon careful planning and sound guidance for continuity of employment, as continuity of employment means happiness, both in and out of the home. Consequently, it is always in the mind of the manager as to how best he can place his men in order to maintain a satisfactory business result. More and more is it becoming essential for a manager to take a broader view on this question of training and guiding the young men of the country towards the most suitable vocation, as without a careful study of this question the best use is not always made of the young material available.

In a business it is necessary to have the correct mixture of optimistic youth and experienced age, as this results in progress of a type which is neither too fast for the adult nor too slow for the youth, always creating an opportunity to find happiness in the task. I feel that there is still something to be done in connection with the question of continuity of employment for youths from the school-leaving age until they become of age, as it must be better for all concerned to have youths coming through to manhood who have had a continuity of wise business discipline, which must equip them better for the time when they have to fend for themselves and their families. These are but my personal views and may or may not be shared by others, but I have made this brief reference as it gives an indication of the thoughts which are frequently in the minds of management.

Another viewpoint on this question, which should be clearly understood, is that it is not just out of the kindness of heart of the existing men in control that employment is offered to the youth of the country, but as I said earlier on, replacements are necessary, and I would make perhaps an even stronger point, namely, that all competent youth has a right to its proper place in industry. Perhaps, however, the graduate should show signs of gratitude and appreciation when the executives concerned show that genuine desire to train, instruct, and help the graduate through the more difficult years of his employment.

No modern management can afford to ignore the vital question of employment and training of the graduate class. On the other hand, no graduate can afford to ignore the vital needs of industry and management. There is no question that the graduate can help the management, but I have taken a broad reference so as to emphasise the importance of the supervision side of management.

What are the Functions of Management, and how are they connected with the Graduate ?

Production may be defined as producing articles to a given specification, in given quantities, at a given price, in a given time. Whilst this in itself is a tremendous task, it only indicates *what* has to be done. The manager, however, has also to control *how* it

should be done, as on this depends very largely whether human beings yield an efficient result from their labours. To-day, therefore, much more emphasis is laid on such functions as planning, inspection, maintenance, good housekeeping, cost control, and research, to name a few, as whilst production and works progressing must continue, developments of the right kind should be continuously introduced.

We find in large organisations that there are a number of comparatively new departmental functions which, in the earlier days, and in smaller organisations, were wrapped up in the minds of a few individuals in any one company. Whilst it has always been found wise to think before an action, it has never been so necessary as it is to-day. This may be the resultant effect of progress, as a mere repetition of a previous action may require little thought, but where the subsequent action has to be something new and improved, then calculations and careful thought must be first applied.

In view of the large commercial risks which are run by manufacturing organisations to-day, there must be a degree of certainty as to the results, as mere guesswork, or lucky shots, can no longer hold out against carefully prepared plans. There are many sections in the main function of planning which offer a vocation of the most progressive type to the young and properly trained graduate. Some years of experience, resulting from applied thought, are required before real progress can be made within this function of planning, but managers of the future will need to have more and more of this type of training and experience.

Inspection.

Inspection has also developed over the years and to-day this function, if properly handled, can have a very big bearing on satisfactory research and investigation, as whilst routine inspection must continne, there is a considerable waste of material and man hours, which can be saved if a proper study is made along the lines of research and investigation, thus effecting a permanent cure at the source rather than necessitating subsequent rectification. This type of work requires practical training, but it needs not only an unbiassed outlook, but also a fair degree of imagination, as the obvious is not always the root cause of the defect. Consequently, the young and imaginative mind can be trained to perform really valuable investigation work.

To amplify the point, take for example, the question of mechanical noise, In order to obtain the necessary degree of quietness, exceedingly expensive production operations are necessary. Production may run smoothly for a week or two, and then comes a period of rejects.

The machine shops may blame the material or the heat treatment

or production methods, etc., the assembly shop may blame the machine shop or design or the suppliers, the hardening department may blame the material. They usually all blame inspection, but by a careful and independent analysis, the real cause can be traced and a cure effected.

With a proper research and investigation section, much of the mystery of recurring production troubles is eliminated, and whilst troubles will inevitably recur, the solutions are ready to hand. Development along these lines offers a good practical training for the graduate, helping him to acquire the ability to sort the wheat from the tares, leading to precise thought and precise action, essential to modern inspection methods.

Gauging Methods.

Gauging methods probably present one of the most interesting studies to the young engineer. I believe that it is only because of the development of gauging methods and procedure that the present day accuracy from the machine tool has been obtained. It is not always appreciated that, whatever may be the production methods, the results in accordance with the specification must be the same.

Whether a part is produced on the finest and most accurate machine tool, or produced by hand, or on indifferent equipment, the finished article has to be brought to the correct degree of accuracy and finish specified for its particular function. We find that quantities to-day have increased, and interchangeability is most essential, so as to be competitive from the replacement cost point of view, consequently efficient and reliable gauging methods are an essential part of modern production.

Young men with imagination and initiative can find much scope in this section, as I have always believed that the gauge is the most essential part of manufacturing equipment.

Maintenance of Plant.

Maintenance of plant to-day again needs to keep pace with other developments, and with the application of more productive and efficient mechanisms and plant, can no longer rely on hit and miss methods. Whilst a resourceful man is valuable in this function, he must also be progressive in his application. Carefully prepared plans for dealing with machinery or plant before it breaks down are usually better than resourceful efforts after a breakdown, as " to keep the wheels turning " is one objective, but " to keep the wheels turning better " should be the true objective. Considerable scope is available under this heading for the all-round practical man, and this function of maintenance, taken in its broad sense, is becoming more and more important.

Various other Functions.

The above few examples illustrate some of the functions of management, and how they are connected with the graduate. I do not propose to go through all the functions in this paper, but I will describe some of the details. There is no standard rule by which works functions are grouped and controlled, but I believe in contact between the works manager and the pupil and apprentice training scheme, as I consider all modern works should have some training scheme, and all works managers should take a personal interest in these schemes. In fact, I regard it as part of their duties.

Welfare. Under this broad heading come such functions as works safety officer, surgery, fire brigade, and now air raid precautions. Also labour employment is included in the more domestic side of management. Each one of these can be a separate function, but all require attention by the management.

Personal Assistants. I believe every manager should have a personal assistant, drawn from the pupil or apprentice group, so that, as part of his training, he obtains a general knowledge of the broad functions of management. There is always an opportunity in the works manager's office for a bright and keen young man.

Planning. I have already broadly referred to this function, and a necessity here is contact with the engineering department. This contact has become more and more important in order to safeguard the ultimate economy in production, without affecting the designer's technical requirements.

Some of the more important planning functions to which I will refer are : (*a*) Allocation of make-in or buy-out ; (*b*) process planning ; (*c*) new plant specifications, either for new projects or replacement ; (*d*) jig, tool and gauge design, and specification ; (e) plant layout ; (*f*) production planning, machine loading, batch quantities, and material priorities ; (*g*) machine tool and equipment demonstration ; (*h*) time study ; (*i*) tool cost investigation ; (*j*) tool room, tool stores, and cutter grinding ; (*k*) planning for future developments ; (*l*) cost estimating for future projects.

(*a*) *Allocation* requires much study of whether a part should be bought out or made in. This depends upon available and suitable plant, economy, degree of accuracy, and control, etc.

(*b*) *Process planning* is becoming more involved. The first obvious sequence of operations is not always the right one, as to-day one should plan with an objective price in view, bearing in mind quantity to be produced and spread over of tool and equipment costs. Time spent on careful process planning very often means large sums of money saved later on.

(*c*) *New plant specification* needs the closest study to-day, as a machine tool is only a means to an end, and enthusiastic engineering

interest does not necessarily give the best economic results for a given project.

(*d*) *Jig, tool and gauge design* must also be on an economic result basis, ingenious and expensive designs must show a return, and at all times should be related to the process sheets and time estimates.

(*e*) *Plant lay-out* requires a very close study to-day, as by careful arrangement many economies can be effected by cutting down unnecessary material movement.

(*f*) *Production planning*, whilst being a widely discussed subject, is very rarely properly applied. By calculating a correct machine loading basis and also economic batch sizes and sequence, much more use can be made of existing machines, with less setting up and idle time. A better yield per square foot of floor space is obtained, and less expenditure on new plant.

I believe that this function has not made proper progress, largely on account of the difficulty in obtaining the right type of mentality to appreciate this problem fully. Much more could be said on this subject, but time does not permit.

(*g*) *Demonstration and* (*h*) *Time study* are both important subjects and should be related to the original calculated times on the process sheets.

(*i*) *Tool cost investigation* is a subject requiring much more study than it usually receives. Often a new and interesting machine tool performing many grouped operations is purchased without a real study of the running tool costs involved. It must always be remembered that economy must be taken over twelve months' running, and not just during peak production.

(*j*) *Tool room, tool stores and cutter grinding* are departments closely linked up with the broad function of planning and specification.

(*k*) *Planning for future developments* should be properly catered for in a modern organisation. Usually works staff are too busy dealing with problems of the present to give much time to the future, but to prevent the expensive business of "digging holes and filling them up again," planning for the future should have its full amount of staff time, and here I would also refer to building planning, as so many of our works in this country suffer from off buildings hurriedly "stuck on."

(*l*) *Cost estimating for future projects* runs parallel with future planning, as all involved costs should be tabulated before a new project is sanctioned.

Plant maintenance. This function has also been referred to, and covers maintenance of boiler, compressors, electricity, gas and water services; plant installation and re-arrangement, plant and building repairs.

Rate fixing. This is one of the most important functions, as it controls the economic price that is paid for work done. Prices

should be fixed in accordance with calculated times based on the correct base rates with proper fatigue allowances, etc.

It is a genuine economy to fix a correct price which, on the one hand, gives the right amount of incentive to the worker, and on the other hand the correct output for the company.

Progress. This is a straightforward function but when linked with material control becomes of first-class importance.

To maintain a correct balance of material in progress and to have something of everything available is a real economy, as manufacturing processes to-day are so interconnected that any individual shortage may cause a serious dislocation and loss of production of the finished article.

Production control is a function usually associated with works having large and varied outputs, as it is necessary to have some organised scheme of scheduling, to interpret sales' requirements into a system understood by the works.

Inspection. I have already referred to this, and the importance of this function does not need enlarging upon.

If one studies the normal function chart of control, one will see a chart, triangular in shape, having a broad base, covering many separate functions leading towards the apex—the one man in control. The functions leading towards the top become less and less, with an increasing degree of responsibility. It is known that there are many levels leading towards the man in control, but however ambitious or clever we individuals may become, there will still only be one managing director in any one unit of a commercial undertaking or enterprise.

I use the word " enterprise," as so many very clever technical men have never reached the top owing to lack of commercial enterprise. In consequence, it is important, in fact wise, to be aware of our limitations, so that even in our most ambitious dreams we do not aim at too impossible a target. This outlook, however, need not in any way affect the full and most intelligent application of our knowledge and experience ; hence each one of the functions normally associated with staff and supervision represents various limits of status. This, however, does not mean that there is any limit to the standard which can be attained, as any one of these levels can be raised to a higher standard, and this is an important thing to know, in order that enthusiasms may be maintained.

I believe that for a workman to improve his knowledge and skill is better for him and the nation, although he may remain a workman, and the same applies right through even to the managing director, as even he, though he may not rise any higher in status, may nevertheless improve his standard.

How are these Functions Controlled ?

At all times there must be a human control. By this I do not mean sloppy sentimentality, but the type of control which, whilst firm, must bear in mind the varieties of the human make-up.

Many useful comparisons can be drawn with labours more closely associated with nature : for example, farming. Whilst nature is actually doing the work of production, it is the controlling hand of the experienced farmer that makes the most use of the soil, seed and the seasons. So it is with the manager, so long as men and machines are employed and working, some production must result, but to make the most use of those men and machines, so that the most satisfactory yield is obtained from the year's working, these forces must be controlled and guided.

One of the first principles of control is the correct co-relation of functions, very much on the lines of a cricket or football team, as it is only concerted effort, from the managing director to the most junior staff, which brings a happy and satisfactory commercial working result. Satisfactory concerted efforts in any staff team depend very largely on the choice of men for the positions available, and this is one of the first important items of management control.

Having selected the team and the location thereof, the next most important step in control is to make the objective clear, firstly of the team, and secondly of the individuals in the team. Let these objectives be as clear as possible, as by so doing, a co-operative spirit will be fostered in bringing to light as early as possible the more serious problems to be faced. By clearly defining the objective, and by deputing work in accordance with responsibility the important problems are brought to light in time.

A production problem only really becomes a worry when it is attended to too late, and there is no pleasure in trying to deal with business worries, and nothing more disheartening. Work at all times should be made a matter of interest, and not of worry, and I would suggest that most of the worries in production are because insufficient time is allowed for a satisfactory solution to be found.

By obtaining a proper team spirit, therefore, there is a better and more progressive atmosphere, prompting doubts and fears to be discussed earlier. A manager who keeps his staff in the dark is asking for trouble. A very open mind must be kept by management, however, on these broad subjects, as I do not believe an organisation should be held to too hard and fast rules, as many times better results are obtained by slight adjustments to suit individuals within the organisation, rather than by enforced replacement from outside.

All staff effort carries with it the control of many hundreds and thousands of workpeople, who in turn are equally affected, as they very quickly know whether a policy of control is a sound and

progressive one or not. It is also important to try to understand the other fellow's problem, whether it be an equal, senior or junior, and consequently I would advise the early development of a broad mind, as this is essential to proper control.

Again, I repeat, that since human beings are the prime movers in an organisation, then one must learn early how to work with them and to use them, very much in the same way that a craftsman, having first selected the correct tool for the job, knows how to use it in order to obtain a satisfactory result.

Under this heading of " How are these functions controlled ? " I have again taken broad references, as I want to stress the great need in industry for executive ability. If this broader view is developed at an early stage in training, it will lead to executive and administrative ability, which is, and always will be, needed in industry.

Can the Graduate Assist in Carrying Out Managerial Control ?

I suppose the first essential of a shop tool is reliability, and I immediately draw a parallel with the graduate, as the first essential of a graduate in employment must be reliability. Reliability and loyalty are very closely akin, as loyalty of the " yes-man " type is not required to-day, but a reliable worker has the first essential for an assistant to a senior executive. I would say here that I believe much more use can be made of young men as assistants to executives, so long as the young men in their turn are prepared to extend their training period.

I would suggest that, after reliability comes initiative, as to anticipate a requirement, to foresee a difficulty, to forecast, are signs of the right type, and very quickly make an assistant valuable. To find a new and better way of doing the same job, to obtain better results by improved methods are signs of initiative. " There must always be a better way " is the best outlook for the graduate with initiative, and providing the elements of reliability are always present, then the application of initiative will be sound and well reasoned.

As the two elements of reliability and initiative are developed, so will the senior executive place more and more responsibility upon the graduate, as real experience will always carry with it a degree of responsibility. Whatever knowledge the graduate has acquired now finds its way to the point of application as once the co-ordinating machinery of reliability and initiative have commenced to function regularly, then the material of knowledge can bə put to some useful purpese.

It is at this stage of the graduate's career that he needs courage, as work tends to become routine, and spare time diversions then

become a great draw. Consequently, I would advise an additional spur to progress, and to venture further and further, so that the habit becomes progress and development, as if a man is to be a successful engineer he must find a real happiness in his work. It is often at this stage that the success of the future is determined, but once this period has been successfully passed, then normal developments, based on the amount of work put in, and knowledge applied, are assured, leading to executive appointments.

It can now be assumed that the graduate has crossed over the barrier reef and is on the open sea, and in order that he may contend with the calms and storms of business life he should acquire the ability to mix well with his fellowmen, but at the same time be satisfied that he is going in the right direction. Thus his character must be of a high standard, developing always the ability to be fair and honest in his dealings.

I believe it is important, and I think in the course of time it will become a necessity, for industry to more clearly indicate its needs in regard to the actual training required prior to employment, and also the number of properly trained youths that can be absorbed. Without this, too much drifting from one job to another will take place, and the time has come when industry, through a properly controlled function, should set out its requirements, both to the schools and to the subsequent educational centres and technical institutions.

Parents also should have a much clearer picture in their minds of the whole period of training, right from the time when a boy first goes to school, up to the first employment, as we may find that very good material is staying outside the engineering profession and going to other professions because the line of continuity right through to employment has not been sufficiently clearly defined for the parents and the boy, during the period of vocational training.

I have endeavoured to indicate, firstly, the need for the graduate in industry, secondly the management's interest in the graduate, and thirdly the type of qualities which are most attractive to the manager. I cannot stress too much the importance of building up a high standard of character, with the desire at all times to find interest in the job in hand, so that when full manhood is reached, there are no regrets of the past, an ability to enjoy the present, with competent enthusiasm for the future. I have made the scope of my references sufficiently wide, in the hope that full and open discussion will follow.

Discussion

MR. GIFFORD: Mr. Hancock has brought up the question of student meetings. I am very glad to hear that you are starting these, because some of the best meetings I have ever attended have been the graduate section meetings of the production engineers, a section which will always deserve the support of the senior members. Secondly, I thank Mr. Hancock for his talk. He has told us so much in detail that there is not a great deal one can say, but there is one aspect that we could discuss, and it is this. There are two sorts of graduates, the graduates of this Institution who, in virtue of their position as graduates, show that they have continued their training through night schools and study, and the other graduates who are graduates in virtue of holding a university degree. Perhaps Mr. Hancock will tell us his opinion of the way in which the university graduate will fit into production engineering.

I am very fortunate in belonging to a firm which runs an extra training scheme for graduate apprentices over and above their apprenticeship schemes. In this they offer university graduates, who have done the theoretical side of their training, an opportunity of doing the practical side. There are very few firms that run graduate training and apprenticeship schemes, especially motor firms. There are a number of pupilages or school apprenticeships, but there is not a very wide application of graduate training, and I suggest that it would be an interesting topic that could be discussed to-night.

There is a committee which has been set up by the engineering students of universities of the National Union of Students. This committee hopes to make contact with professional institutions such as the Institution of Production Engineers, the Mechanical Engineers, and Civil Engineers, and so on, in order to exchange points of view and to pass on the opinions that students and graduates have made at the conferences run by these students. Amongst the points that have been brought forward and emphasised are, first of all, that this graduate apprenticeship should guarantee more than a nominal wage, because a university graduate, who has been straining his parents' purse for a good many years feels he ought to be just about able to live. He should also be looked upon by the firm as an investment.

What type of training should this be? Our concern also was, possibly more than anything else, what should the curriculum be? The universities themselves are becoming conscious of this matter at the moment. Now is the time for the engineers to tell the universities what they think. In connection with this, the British Asso-

ciation has set up a committee of leading industrialists and professors from the universities to reconsider the whole question.

Finally, there is one very important point that the N.U.S. committee has emphasised—the facilities for vacation training. The university student leaves school at eighteen. He has not seen much of the world and at the university he gets a lot of theoretical training, some of which is quite out of touch with the practical side of his work. Also, he gets long vacations which he often wastes, and usually he will not see much of engineering. There are increasing attempts to get these undergraduates into engineering works during vacations for a month or two, at a very nominal salary, in order that they may meet industry and industry may meet them.

It is possible that a graduate will go to such a works and will find he does not like heavy engineering, or does not like light engineering. He has only spent a month and has not wasted that, but has learned quite a lot. It will enable him to see some engineering and find out which particular niche in engineering is his. It also enables the management to watch him and if they do not like him they won't engage him. It will save wasted time through people taking the wrong careers and firms taking a type of graduate which does not suit them.

Mr. Hancock: I would like first of all to refer to the question raised regarding the employment of university graduates. From my own personal experience I can state that there are vacancies in the engineering world for a number of university graduates, providing these are, in the first place, carefully selected, and in the second place, that the right type of occupations are found. This particularly refers to the earlier part of employment, so as to lead the graduate into an engineering business in the right way. On the question of vacation training, I do not consider one or two months in the works is of any real value, other than to show the graduate what a works looks like.

There are two main approaches to administrative positions in an engineering works. The more usual one is by serving a full engineering apprenticeship, with part-time technical college training, commencing apprenticeship at approximately sixteen years of age and finishing at twenty-one years of age. The other is a university training and subsequent study of the practical side, finishing at twenty-two or twenty-three years of age. The former method leads to earlier employment with responsibility, as the practical experience gained during apprenticeship can be more readily applied, providing, of course, that the correct technical standard has been achieved.

The problem of management, however, as referred to and stressed in my paper, is the need to have practical experience as well as

technical knowledge, and therefore the university man has to catch up in his last year or two by intensive practical training, so as to acquire a satisfactory balance of experience.

I was interested in the reference made to the National Union of Students. Any open discussion which takes place amongst young men will be helpful both to the educational authorities and to industry, as the gap which exists to-day between education and employment needs to be bridged, so that there is a clearly defined route mapped out from training to employment, both from universities and from technical colleges. Regarding the question raised by Mr. Gifford that a graduate may not like a particular branch of engineering, all pupilage schemes should carry with them a probationary period.

MR. DUNCOMBE: I cannot help thinking that the universities are in grave danger of becoming technical schools rather than universities. I think that the purpose of the university is training for the mind rather than just a place where one acquires learning and gets that knowledge which is obviously needed to enable one to take one's place in industry. It seems to me there should be a fairly sharp definition between the technical school and the university. Both, I think, are necessary. A person should have a training in matters which directly affect his career, but also should have a training which is quite theoretical and which has not necessarily any direct bearing on what he is going to do in future, in order to train his mind to deal with wider problems which he will come up against later on. Those problems are sure to be very wide if his position is important, and I cannot help thinking that a purely technical training in that case is not adequate. I dare say Mr. Hancock agrees with me thus far, but I would like to know what he has to say on the danger of running the two together, perhaps to the detriment of both.

There is one other point I should like to mention. I am not sure what he means by "executive position," I imagine that a ratefixer, for instance, would be called an "executive" man, but I rather think Mr. Hancock is using the term in another sense, a sense which I have always thought of as "administrative." I should very much like to know if he can define these two terms.

MR. HANCOCK: I appreciate the points raised by Mr. Duncombe, and so far as I am concerned there was no suggestion that the universities should turn into technical schools. I agree that the university training should have a broader basis, but if the university graduate feels that he should come into industry, then the university curriculum should line up to some extent with the needs of industry. A young man who studies too long the theory of things may become merely a reference library and may have very little ability to apply his knowledge, and therefore will still need some

years in industry before he becomes a competent manager, as I have made it clear in my paper that one should have practical experience in order to properly control practical work-people and staff. With regard to the use of the word "executive" I mean both executive and administrative positions.

MR. A. YOUNG: To get back to this question of the univeristy graduate versus the lad who has worked his way up by apprenticeship, I think, as far as works management itself is concerned, in this country a lad who has worked his way up via apprenticeship has very much greater opportunities. For the most part I think we can make the safe admission that the university graduate has something more to offer for sale than the fellow who has started as an apprentice, but I do not think he has the right goods to offer, and this is largely due to faulty curriculum, syllabus, and so on. For instance, there are various professional institutions such as the Institution of Civil Engineers and the Institution of Electrical Engineers, and at most universities you can become an electrical engineer or a civil engineer. It is a recognised profession and proper entrance can be made via the universities into these professional institutions, but not so with production engineers. There is no university in the country catering for production engineers—that is, there is no suitable department in their engineering faculties. Though its technique is rapidly developing, it has barely been heard of within the precints of some of our universities, and I think that a few meetings like this might possibly be a means of getting something done.

There are organisations such as the National Union of Students which have awakened to that fact. They recognise that many of the jobs they would like university graduates to get are in the direction of works management, but the universities are not catering for it, and they must do so. They must recognise that there must be a syllabus laid down. Of course there are difficulties. Further than that, we want training in production engineering to include training for works management—we want some sort of factory in which we can give practical instruction. I think it is for the universities and industry to combine there. They have got to recognise the status of management itself, and consider the student rather later on in life. The student should set out to become a works manager, just as he might set out to become a doctor or a parson, and ask for the proper course. So, I think, it must be with works management, but of course it will only slowly develop. The universities have never heard of production engineering technique, and they do not recognise that a man who is in the position of a production engineer has the same status as a doctor or a parson and must be given adequate training.

MR. HANCOCK : As I have already indicated, if the universities are going to cater for the production engineering profession, and its management side, they will need to adjust their curriculum accordingly. I believe that in the course of time this will be done, as production engineering has already become one of the most important professions in the country, and the educational authorities will need to see that the proper background training and instruction is provided.

I agree that the status of the production engineer should be properly recognised, and that it should be possible for young men to receive instruction and information which will equip them for these responsible positions in industry, but these observations apply to any of the existing training and instructional schemes, and I believe that this type of open discussion will help the education authorities to appreciate the important part which production engineering plays in our national life.

You will notice in my paper how I have emphasised the importance of continuity right through to employment, and this will only be brought about by both industry and the educational authorities getting closer together. This Institution is doing very important work in this direction, and there is no doubt that in the course of time we shall see an improved condition. I myself have two sons who may decide to become engineers, and as a parent I am bound to be influenced if I see a scheme leading right through from their first attendance at school to employment. You will appreciate, therefore, that I have a very personal interest in this question.

MR. MARSH : There is one criticism which can be levelled against the employment of university graduates. I have experience of a firm which has not a single university graduate amongst its twenty-five thousand employees. That is not by design primarily but is due to experience. It can be explained if you will take the speaker's point as to the qualifications which works executives should have in order to be successful. If you ask " What initiative can a university graduate show when he goes through a factory ? " you will find that his scope is very limited, because in any direction in which he wishes to show his initiative he will be up against obstacles and against people of whom he has never heard before. He does not know the routine of business and, as far as mixing is concerned, he is badly handicapped. He has not worked amongst people in all grades of employment in a factory. You must be there for years before you can understand the feeling and gauge the relationship between employees and employers.

MR. HANCOCK : I do not agree with any firm who, as a policy, does not employ a single university graduate, although I agree that the present system makes it easier to employ a boy who has been apprenticed. I have had very satisfactory experience with university

graduates, but as I have previously stated, they have to continue their training period perhaps two years longer in order to acquire the necessary degree of experience. A lot depends on the individual himself, and how keen he is to catch up with practical experience.

MR. GIFFORD : I feel, possibly, the other side ought to be represented too. We must be careful in dealing with this question. It is a question which has received a good deal of limelight in industry, and it is one which must be understood and not influenced by prejudice. There is a great deal of prejudice on both sides. There are many university graduates of the type described earlier in the discussion who will not or cannot roll up their sleeves to a practical job. There are, on the other hand, university graduates who realise what they have missed so far and have got enough sense to realise that they are in the shop to learn to do the job ; they are on good terms with the men and are accepted by them—I have seen that happen in many cases. There are good and bad, and the last speaker has possibly been unfortunate in some of the graduates he has met.

He says : " The university graduate knows nothing about industry, therefore he is no good." It is understood now, I think, that if a graduate expects to do anything in engineering he has got to spend at the minimum two years, possibly more, and, just as an apprentice, go round and do the job. He does not take any responsibility, he is not even a charge-hand, but just an ordinary operator. A boy who starts work at fourteen knows nothing about the job—everyone has got to learn sometime. The university graduate merely starts a little bit later.

If the boy in the shop wishes to get on to a position of manager he has got to go to night school and extend his knowledge. That same boy might have been lucky when he was younger and got a scholarship, and that scholarship to a secondary school might have been succeeded by one to a university, ultimately producing—*from the same material*—a university graduate. He will then have to go back and catch up with the practical side. Both have had nearly identical training except that they have had it the other way round. The only thing is that night schools entail hard grind, on top of a day's work, and the man who is trained this way might conceivably miss, through no fault of his own, the more fortunate or cleverer man's opportunities for cultural and general education. This wider education, over and above mere professional or technical training, serves to develop personality—so often the basis of a successful manager's character.

MR. HANCOCK : There should not be any prejudice either on the university graduate's side or the apprentice's side, as in my opinion there is a need for both in industry. Progressive firms to-day allow time off during the day for their apprentices to attend technical

college, and by so doing they can at least obtain a higher national certificate. Many years ago, attendance at night school was the only way of obtaining technical instruction, but this has improved considerably during the last few years, and the technical colleges in some districts in this country provide very good day-time classes, and this scheme is worked in conjunction with the employers. The important point, however, is whether the instruction which students receive is properly equipping them for production engineering and its managerial and organisational responsibilities.

MR. EDWARDS: Mr. Hancock referred at the commencement of his paper to an advisory committee used in the organisation with which he is connected. I would like to have further information as to what work this advisory committee carry out.

MR. HANCOCK: The advisory committee to which I referred assist the apprentice supervisor in his normal duties. They are drawn from different departments themselves, ex-pupils, and do materially assist, first of all on the social side, and they also advise the management in regard to possible improvements in the training scheme as a whole, and draw the management's attention to particularly bright and progressive apprentices and pupils, so that before the apprentice or pupil completes his time some further interest is taken in him by the management and he is led towards mutually agreeable employment I believe that in the last year of a youth's training in the works he should specialise in a branch of the industry in which he is most interested, and in which he shows the greatest proficiency, as I think it is wrong merely to train youths with no particular purpose in mind other than the training.

MR. WHITE: I suggest that a fully trained engineer with a university trained man on the one hand and a practically trained man on the other should manage a factory well, using the university man for knowledge and the practical man for application. To-day you will find that a large number of managers are virtually cost accountants.

MR. HANCOCK: The point raised by Mr. White is covered in my paper, and regarding the question of managers turning into cost accountants, this does in fact form a very important side of management, as unless one can manage a business in such a way that it yields reasonable profits, then, however good may be the technical achievements, the business is a failure. Therefore it behoves all who are interested in reaching a high standard of management to include in their studies this all-important question of costs.

MR. I. H. WRIGHT (Section President, who occupied the chair): We had hoped that Mr. Groocock, who was largely instrumental in starting this series of papers would be here to-night, but unfortunately his health has prevented him from coming. Mr. Youngash,

who gave us a paper in this series last year, also hoped to be present but has been prevented at the last minute, so I would just like to make one or two comments.

The series dealt first with "What the graduate should know." That is, the educational work he had to undertake. Secondly, "What the works could for for him"—the training he should have in the works to become a useful unit in the organisation and mix with his fellow workmen, and to-night, the third of the series dealing with the attitude of management towards the graduate. I think we can sum up the result by stating that the graduate must assimilate his education so that it gives him sound judgment in mechanical matters, shop matters, and human matters—knowledge which comes from actual application and experience, and which generates self-confidence. Having got that confidence, he will be in a better position to give instructions to the people who are under his supervision later, and so take a step further, that is, the acquisition of wider knowledge and reliability of judgment.

Mr. J. W. Berry: I think the "feud" over the university question is one of the most useful happenings that we have had in any meeting of this graduate series, because it has opened up one of the greatest difficulties in the education of production engineers to-day. Both sides have their difficulties, and I should like to say "Good luck" to your University Students' Union, because if we get a push from you, I think we can do something.

I am against a university training because the most important feature of management is being in a position to understand the people whom you control, and in my opinion monthly or two monthly periods in the the workshop are hopelessly inadequate for that side of the training. If it were possible, I think a six-monthly period would be ideal, that is, six months in industry, six months in the university, and it may be possible in future to persuade some of our academic fathers to consider splitting up the academic year on that basis. You would get a complete programme in that way, and I am confident the result would be worthy of the effort. If we are to hold our own in the world's markets, we must wake up.

We have been listening to-night to representatives of what I might term advanced thought on the side of employers, both from Mr. Marsh, who represents an excellent apprentice scheme, and our speaker. On reading through the application forms for our graduateship examination, which takes place in a month's time, I found on one student's paper that he had been having private study because he was not allowed time to take up evening work. He had already spent three years at night schools. To my mind it is a disgrace that a youth who has shown himself to be ambitious should have his studies cut off at their most important point. I would give one word of warning against correspondence schools. I do not condemn

them out of hand, because in some cases they are very useful, but generally speaking, if you want good training take it from the local technical institute and try if possible to get your employer to give you time off during the day. I would ask you to support a most hearty vote of thanks for a really interesting paper, a paper to which Mr. Hancock has given a great deal of thought.

MR. HANCOCK : I appreciate very much indeed the remarks made by Mr. Berry and the way in which I have been received here this evening. If I have done anything to further a cause in the interests of the young engineer, then my humble efforts in compiling this paper have been fully rewarded. I trust that to-night a plank has been placed across the gap existing between the university graduate and the engineering apprentice, and that the discussions will continue between them, so as to bring them together. I believe it is a matter of national importance that this should be so, and that it is for the educational authorities and industry to help to bring this about.

PRODUCTION ENGINEERING RESEARCH

Paper presented to the Institution, Sydney (New South Wales) Section, by E. C. Parkinson, M.I.P.E., Section President

Research.

BEFORE dealing with the subject of this paper specifically I propose to say a few things about research generally. Charles Franklin Kettering, Vice-President of General Motors and the distinguished head of its research laboratories, said not long ago: "Most business men say they are keen for research, but they don't know the first thing about it." There may be some truth in that statement.

Research you will find defined variously as "careful search or inquiry after," "Endeavour to discover facts by scientific study of a subject," "Course of critical investigation." However, I think Mr. Kettering's idea of research is expressed in a nearer approach to the language engineers understand. "Research is industrial prospecting" or, "Research is an organised method of finding out what you are going to do when you can't keep on doing what you are doing now." That is the type of research we are interested in.

Every industrial country has its department of industrial research. It is estimated that Great Britain has some 20,000 to 30,000 research workers constantly on industrial problems; America some 30,000; Germany probably nearer 70,000; and U.S.S.R. in the vicinity of 100,000.

American industrial research, for all the wonders ascribed to it, is, in fact, supported with more words than dollars. It costs industry something like $200,000,000 a year and, as mentioned before, provides employment for 30,000 research workers. It is interesting to note that according to the National Research Council, two-thirds of U.S. industrial research is aimed at either improving existing products or reducing their cost of production. Its purpose is immediate profits and its budget is answerable for tangible results.

Research is not magic, but a slow, pedestrian process of cut and try. It is also a yeasty growth, one problem leading to many others, with very often the original research idea being left behind in the pursuit of the interesting and oftentimes very profitable solutions of the problems arising.

The research worker's impatience with the average business man is eloquently expressed in the following words: "If we tried to

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raise human children the way we want to raise industrial children, the human child would be earning its living when it was nine months old." Research takes time in plenty. It has been stated that: "The cost of research may be of two kinds. There is, first, the cost of doing it, and there is second, the cost of not doing it, and the cost of not doing it may be—it is indeed quite likely to be—much the greater of the two."

What Research has Accomplished.

I think this can be expressed very well by saying that research has been the means of providing "more and better things at lower prices for more people." Probably a real research worker would be somewhat shocked to have it expressed in such a manner, but does it not sum up the position? Let us look at the U.S.A. at the beginning of this century and what do we find of what to-day are looked on as necessities? Only one American house in seven had a bath: one in 13 had a telephone; one home in 300 had electric lights—no radio. There were only 8,000 automobiles. Manufactured products were scarce and expensive. To-day there are 20,000,000 baths, 18,000,000 telephones, 22,000,000 homes wired for electricity, 25,000,000 automobiles and millions of other manufactured products which were unheard of in 1900, but are now plentiful and sell at a fraction of their former cost. Research workers have helped to provide us with the many products that contribute to our comfort and convenience and to hundreds of services which we enjoy to-day. It is claimed by the General Electric Company, that their research and engineering have saved the public from 10 to 100 dollars for every dollar earned for General Electric. The scientists, engineers, and workmen of industry have developed hundreds of new products, have continuously improved them, have learned how to make them less and less expensive so that more millions of people have been able to buy them.

Let us look for a few minutes at such a common commodity as glass. A leading research worker in the Corning Glass Works is said to have passed this remark: "I think we make a mistake in our ads," he said, "we're always talking about the things Corning makes out of glass—we never talk about the glasses Corning makes." It sounds unbelievable, but Corning has developed more than 25,000 glass formulae. Every day chemists pour widely varying raw materials into rough clay crucibles to obtain more types of glass. The results are to the glass maker what seedlings are to the nurseryman. Some are discarded, some are used. This is the kind of work that has made Pyrex heat-resisting glasses an actuality instead of a dream, that has developed glasses of a hardness that compare with steel, that has produced the worlds largest telescope mirror, which it is interesting to note, is now out in

California where men are in the fourth and final year of patiently polishing the largest piece of cast glass in the world—200 in. diameter. Corning is using more than 250 different formulae in daily production.

The time available will only permit us to glance at a few other things scientific and production engineering research have made possible.

Armaments.

At this time far more research workers, both forward and engineering, are concentrated on this one item of destruction than on any other item or group of items. For some idea of the problems overcome and constantly under investigation we can do no better than take a few examples.

Ammunition for artillery and small arms places the heaviest burden on the metal and machine tool industries and what problems this has presented!

Artillery ammunition. From copper and zinc to brass, to the automatic shop for fuses, to rolling mills for cartridge cases. Then drawing and machining. Iron ore, silica, manganese and coke to steel. Through rolling mills, forging plants, machine shops. Then the explosives side and all to the filling factory, proving ground and destruction.

Small arms ammunition. Brass again for cartridge cases, lead and antimony for bullet cores, tungsten steel for armour piercing bullet cores, copper and zinc for gliding metal for bullet jackets, tracer composition.

Consider also small arms manufacture, the optical instrument side, artillery manufacture, armour plating steels, then shells to penetrate them, better armour plating steels, shells to pierce them, and so it goes.

With such a brief review we can appreciate the work performed by research workers of all types who have worked so long and strenuously to make possible the production of armaments in quantities and of a standard required for modern warfare.

Aircraft.

What developments have taken place in this industry! Take the engine alone, and let us go back only ten to fifteen years. As engineers, what should we have said had anyone told us that in that comparatively short time we should see engines made, and in regular service, with a weight as low as 0.7 to 0.8 lb. per horse power? That is an amazing achievement.

Apart from engine, instruments, landing gear, propellors and other fittings, one can say that aeroplanes are still hand made. The components mentioned can all be handled very rapidly by

the usual line assembly methods, but not so with the fuselage, wings and so on. In some stages of assembly it takes two men four hours to rivet a single foot of a metal plane's surface. For years aviation experts have been praying—more fervently than ever, since Munich—and now—for some method of producing planes as rapidly as cars. Their prayers seem about to be answered. A new plane-making technique promises to make possible a practically unlimited supply of stout, cheap, fast airplanes- using a laminated plastic. For over a year and a half planes made of this material have been undergoing all sorts of endurance tests. It is claimed that a plane fuselage can be moulded and made ready for the production line in two hours, and also that : " In the form of a simple thin walled cylinder of given weight under compression, the material from which it is made is, roughly 10.4 times as strong as stainless steel." Soon wings as well as fuselage will be made of this material. Even now this material can be pressed into sections long enough to give a wingspread of 85 ft., ample for most military purposes. Because of its seamless, rivetless skin, it is claimed that a plane made of this material will be, theoretically, 7% faster than its all-metal counterpart. At 300 m.p.h. this would be a gain of 21 miles. The effect of this type of construction so far as production is concerned can be gauged in this manner.

The German war plane programme calls for approximately 160,000 skilled workers in aeroplane plants alone, plus 240,000 more to make parts. With 10 sets of dies, 200 men, it is estimated, could build enough fuselage, wing and tail shells for 300 planes a month, or with 100 sets of dies 2,000 workmen, only semi-skilled, could in a year mould and assemble 36,000 planes. Just what effect all this will have, remains to be seen.

Radio.

The work of the early research workers has been carried on by thousands of others in all parts of the world, with such amazing results, that in a few short years it has almost become commonplace. What, but a few years ago, was looked on as a novelty—something for a few experimenters to play with—has now become a necessity and as far as domestic radio is concerned, is listed as such by the research workers into cost of living in this country. Such things as beam wireless, picturegram service, overseas radio telephone service, aircraft beacons, and so on, no longer thrill us but are looked on as ordinary services of these modern times. Out of all this research a very large industry has grown. In this country alone it is estimated that over 10,000 people are engaged in the industry, with wages a bill of about £2,000,000 per annum, and a turnover of business of close on £10,000,000 a year ! At the end of 1938 America had more

than 40,00,000 radio sets in use. Now one hears little mention of radio, as we now know it, but a lot about a new development—television.

Television.

Most people look on television as something quite recent. It is interesting to note that by 1911 the complete outlines of the present system of television, unworkable but theoretically perfect, had been laid down by scientists. The work of the last thirty years has been improvement, and at all times in the last twenty years there have been television systems in experimental operation. Even public television broadcasting is not new. For several months in 1931 New York radio stations transmitted regularly announced programmes, and for almost three years England has had a regular service. This year regular broadcasts have started in America. The research work in England to date has cost in the vicinity of £2,000,000, and America in the last five years has spent $13,000,000. To date, television's reception by the general public has been disappointing. In England some 12,000 sets have been sold in about three years. The B.B.C.'s over-all expense for three programme hours a day is more than £400,000 yearly. American manufacturers estimate sales of 20,000 to 25,000 sets this year. There are many difficulties to be overcome, but they will be overcome.

To date, as mentioned previously, America has spent some $13,000,000, and this is what they hope to get out of it.

			Ave. price
1939	20,000 to 30,000 sets	at	$300 each.
1940	199,000 sets	,,	$250 ,,
1941	414,000 sets	,,	$200 ,,
1942	846,000 sets	,,	$160 ,,
1943	1,371,000 sets	,,	$150 ,,
1944	1,903,000 sets	,,	$140 ,,

This anticipates the sale of more than 4,760,000 television receivers in six years at a cost to the public of $750,000,000! Granted, this is sales department mathematics, but it proves there is nothing small about the ideas that are circulating in the television business. To the radio industry, thanks to research, television may prove to be "What it is going to do when it can't keep on doing what it is doing now."

G.M. Research Department.

We all know the products of General Motors and a glance at the research division in Detroit should prove of interest. The man in charge is Mr. C. F. Kettering. An eleven storey building houses this section and contains about 250 skilled mechanics, 150 technical

research workers, 100 students, clerks, and others, and has really little interest in strict product research, which is taken care of by a fully equipped engineering department in every G.M. manufacturing division. The work of this section can be divided roughly as follows: (*a*) 40% consultative engineering on specific product problems at the behest of the manufacturing divisions; (*b*) 40% advanced engineering, such as finding the upper limits of Diesel performance or trying new gear materials; (*c*) 20% pure science—the nature of combustion for example, or of friction. The annual budget is approximately $1,500,000.

Kettering is impatient with long words. Thermodynamics, he describes as a big word covering up our inability to understand temperatures, and the second famous law of dynamics he formulates neatly as follows: "If you are going as fast as something else, you can't push on it." Another saying of his, too, is interesting: "Any problem, thoroughly understood, is fairly simple."

The chief purpose of G.M. Research, or for that matter almost any research, can be said to have the following purpose: "To supply new industrial projects to society." The findings of this research department are made available to, and frequently commercialised by, the product research department attached to each of G.M.'s manufacturing undertakings. Their work is that of to-day, a few months ahead or, at the most, about two years ahead, and their problems are those of production engineering on a very vast scale—a million or more cars per year!

Co-ordinating forward research with present day engineering, making use of any development of the forward lab., generally restraining the more revolutionary research man wanting to change established things overnight, holding back developments for which the market may not be ready or which require such great changes in production equipment and plant layouts as to make them impracticable. That is the full time job for another G.M. executive.

Production Engineering Research.

My remarks on research, what it has accomplished, and a glance at a research department, will no doubt indicate what a tremendous field production engineering research has to cover and just how impossible it is to do any more than skim the surface in a talk of this kind. Every production engineer makes use of the following: (1) Raw materials, chiefly metals; (2) machines; (3) cutting tools; (4) supplies such as oils, cutting compounds, hardening compounds, cleaning and plating solutions, etc.; (5) labour.

In producing his parts he makes use daily of standard fits and tolerances, and many other standards which, after critical investigation, have been found best suited for the type of work he is

engaged on. Simple as some of these standards appear, they frequently represent years of work. Now, just think again of the the five items mentioned, raw materials, machines, cutting tools, labour, and supplies, and let us look at each in turn.

Raw Materials—Iron and Steel.

This covers such an extremely wide field of real productive work by research workers that it is difficult to know where to start. The commonest of all materials we use are iron and steel. We take iron and added to it .1% of carbon and produce a metal of very widely different properties from the pure iron, and the mechanical strength is raised from 14 tons to nearly 30 tons. Increases of the carbon content will further increase the strength until a percentage of 0.9% of carbon is reached. There is no very convincing explanation of this, but we do know the results obtained. Again, by hardening and tempering we obtain properties greatly in advance of those obtained by the simple addition of carbon.

The addition of alloys then opens up another very wide field. Nickel and nickel-chromium, manganese-nickel-molybdenum, nickel chromium-molybdenum vanadium, giving us steels, with suitable heat treatment, with maximum stresses up to over 100 tons per square inch.

The hardening of steels by " nitriding " opens up a further field, again with the use of the alloys in correct proportions. Compare a carbon case-hardening steel with a special alloy steel, which instead of being given surface hardness by carburising, is surface hardened by heating in ammonia gas at 500°C. The addition of such alloys as aluminium, chromium, and molybdenum, nickel and vanadium, in suitable proportions, enables the engineer to fabricate a part and then, instead of heating up to about 900°C. for carburising, simply maintains it at 500°C. in ammonia gas and obtains intense hardness. The time taken is certainly longer, but the hardness achieved in the case of chromium-aluminium steel is generally over 1,050 as compared to 600 to 780 in the hardened carburised case.

Then we have our stainless steels which to date have caused much heart-burning for production engineers. It is now claimed by certain steel makers, that with no sacrifice of stainless properties, stainless steel can be produced to machine as easily as free-cutting mild steel. Speaking of free-cutting mild steel, what improvements have been made in late years! Production engineers are now beginning to feel that after all it may be correctly named. Very recent developments are the lead alloy steels producing extremely free-cutting materials, and making possible the production of parts with speeds and feeds usually associated with some of the kinder non-ferrous metals.

Tool Steels.

What strides have been made here! Practically non-shrinking steels, uniformity regardless of section or whether purchased last year, this or next year. What a relief this is to the tool room man of to-day, who, not very long ago, was in the habit of saying a few silent prayers whenever one of the products of his skill was put in the furnace and, after careful heating, quenched. It needed a man with a stout heart to stand up to the strain! We have seen them, all of us, straining their ears for that click which means so much, and which if not heard meant that one grave risk was passed. Then to find out just how much it had changed shape and just what he would have to do to correct it. At last all is set for production. It may be a press tool, a set of dies for hot pressings or a drop forging. What a relief when the first few come off the tool and it is still intact. Such things are fast disappearing and casualties of this kind are a very rare occurrence in the modern tool room. On the press tool side we often hear it said: "You just can't wear them out." Certainly we can get some real production from a well-made tool. For the drop forger and hot presser similar advancement has been made and the blanks per tool are greatly in excess of a few years ago when we used to watch for those hair lines on the surface of the die, see them multiply and not long afterwards our perfectly good die just fall to pieces.

Special steels have been developed to help us get production from our plastic moulds. Steels to give a high degree of polish, a hard skin with a very tough core to stand up to the high pressures used.

Sheet steels, available to meet any conditions, uniformity of gauge and product, special steels for electrical work, deep drawing, enamelling and so on, are also things for which we can thank the research worker.

Cast Iron. Malleable Iron.

Much work has been done here, and again uniformity and machineability have been improved. Countless experimental casts have been made using suitable alloys to provide castings to meet the requirements of this manufacturing age. Not only has work been done on the materials themselves but it has been proved beyond doubt that the sand in which it is cast plays a most important part in the quality and uniformity of the finished casting and now "conditioning plants" for foundry sands are found in most up-to-date foundries.

For the research worker in iron and steel we should be eternally grateful. They carry on under extremely difficult conditions of heat and labour and yet maintain scientific control. We thank them for the efforts!

Non-ferrous Metals.

Brass, bronze, aluminium and its alloys and so on. We are all familiar with these metals and handle them daily, but let us look for a few minutes at aluminium. A few years ago this was a comparatively useless material although available in very large quantities. At one time it appeared to have little, if any, engineering application—the kitchen was about as far as it went—but research got to work and to-day with its alloys it is an extremely useful and widely applied metal, with excellent mechanical properties. The developments have been most interesting and due to its lightness combined with the mechanical strength obtained by using alloys it is now displacing many of the older metals.

Other Raw Materials—Not Metals.

Probably the most important in this group is plastics. Most of us are familiar with the results of the research work of Dr. Leo. Hendrik Baeckeland, how since 1907 he has been known as the father of modern plastics. Out of this has grown enormous industry which has made possible the production of articles at a price impossible by conventional methods and materials. What problems have been set for the production engineer in this alone! Those problems have been, and are being solved, and as a result another great industry has had its being.

Plastics can be divided into two major groups—thermo-setting and thermo-plastic. The first are the phenolic resinoids, which are the better known to us here and which include those beautiful urea materials. Products are made by pressure moulding in moulds heated to usually around 340°F. for the phenols and 300°F. for the ureas, are cured for times roughly proportionate to their thickness and are ejected from the mould whilst hot.

The thermo-plastics can be moulded by the usual pressure method, but there is no " curing " time as we know it in the case of the first group, and the moulds have to be cooled off before the mouldings can be withdrawn. Generally these materials are moulded by the injection method.

This group of materials has opened up an entirely new field for the research worker not only on the material side which in itself is a major problem, but in steels to stand up to moulding conditions, machines in which to produce, mould design, drilling, tapping and finishing methods, and all who are engaged in any way in this industry see the practical results of this research. Great as has been the development of this industry, one cannot help feeling that the next few years will see greater development and a much wider application. Speaking generally, it can be said that engineers have not yet fully appreciated the possibilities of materials under the heading of plastics.

Machines.

We have all seen considerable progress in machine tools in the last few years. The makers of machine tools are constantly engaged in improving their products and broadening their field of application. The competitive nature of their work calls for constant research and with it further improvements and greater productive capacity of their products. Developments are so rapid that it is extremely difficult for production engineers to decide which method of attack on a problem is the best, as a number of alternative methods of arriving at a given result present themselves. The general large increase in operation speeds, built-in motor drives or single pulley drives practically wiping out the cone drives of only a few years ago. The increased use of air chucking, the passing of the shaft with its conventional key or keys to make way for spline shafts, the almost universal use of ball and roller bearings, the improvements in, and decrease in, size of driving clutches and many others we could list, are all improvements for which we must thank the research worker.

An excellent example showing a combination of many design improvements is the headstock of a modern all-geared lathe. Look at one and then take your mind back a few years to the lathes which were our willing servants and really there is no comparison. The special steels developed for gears and other highly stressed parts, correct heat treatment, lubrication, more accurate machining of parts made possible by machines built to build machines. As production engineers we must agree that considerable improvement has been made. We no longer think of around 700 r.p.m. as the top speed of our lathes and other machines, as speed two and up to 10 times greater are so common.

The machine tools we have all known so long are improved so much that those of us who had our training on the older planing machines, shapers, lathes, automatics, milling machines, grinders, drilling and boring machines, cannot help admiring these later products and often wishing circumstances would permit our getting away from the many worries most of us have, to operate them. These improvements have been made possible because of the research work put in on the production problems encountered, This has led to the development of new machines : Gear grinders spline grinders, machines for grinding the beds and slides of machines, centreless grinders, and so on, to great improvements in electrical equipment : motors which can be reversed up to 40 and 60 times per minute, the electric drive of a modern planer is another good example.

Running parallel with this machine work, has been that of the research workers engaged in the investigation of testing equipment so that the production engineer and others would have a proper

yardstick for each of his problems. As a result hardness testers of all kinds, machines to determine the physical properties of metals, projection machines, measuring machines of all kinds and for all purposes are readily available.

New machines are being introduced and new applications of old machines. Dealing first with, shall I say production machinery, we have the thread grinder, now looked on as a production machine, and one might say, for the first time, making possible the production of accurate screw threads in quantities. Hydraulics are now playing a big part in machine design, and some excellent work has been done in the application of the age old principles to modern machine tools, grinders, shapers, etc., are good examples. In addition, we find the hydraulic press coming back to the engineering shop. The development of plastics has led to considerable improvement in hydraulic production machinery and some really excellent machines have been produced. Now we find the hydraulic press gradually replacing the large mechanical presses used for producing deep drawn sheet metal articles—motor car headlamps for instance. With the improvements in valve gear and methods of operation they are by no means the slow and cumbersome machines we knew some years ago. They are producing a better job, quicker than the mechanical giants previously employed.

The same principle is being applied to machines for surface broaching—a comparative newcomer to the production engineer but one which is being used with marked success in the motor car industry in Great Britain, and giving production times and a quality of product not attainable by any other method.

Then just a glance at another newcomer—welding machinery, and we join that with the modern equipment for cutting materials with a gas flame. A tremendous amount of work has been done in this field and spotwelders, butt welders, projection welders, many fully automatic in operation, in addtion to the hand welding operations both gas and electric, have opened up a new field for the production engineer. We take these things as they come along, very often without pausing to think of the " prospecting " which has been necessary to make them possible.

As new methods of production have been introduced so have special machines been developed to aid in production. With the advent of plastics, drop forgings, hot pressings, and die casting came the need for some machine or machines to help us produce the necessary dies better and quicker than could be done with our conventional machine tools and hand methods. The duplicating machines and automatic die sinking machines were the result and, thanks to them, we can produce our dies and moulds in very reasonable times without having to employ an army of men skilled in the use of the hammer and chisel, rifflers and files of all sorts of shapes.

Another very interesting method of producing die and mould cavities is that of making a hardened master and using a hydraulic press, pressing the master into the soft blanks which are to become the inserts for the mould or die cavity. Those of us who have had to make use of this " hobbing " method often wish that the research work performed to date, in all parts of the world, could be got together and presented to us in book form. It would save us lots of headaches.

As machines have been developed to help us in the production of moulds and dies, so have they been made available to us for the making of press tools and, to-day, no tool room with any sort of a press tool programme can afford to be without such machines as metal bandsaws, die-filing machines, punch shapers, or those wonderful small milling machines with more attachments than machine, which put up such performance records on the many peculiar shapes which have to be produced every day in the busy tool room. With equipment of this kind available to us it is not so much a question of " Can we afford to make tools " as " Can we afford to do the job without tools ? "

One could continue with this vast subject and look in detail at the modern die-casting machines, injection moulding machines, and many others, but time will not permit and we pass on for a glance at some other products of the research workers of engineering.

Cutting Tools.

Now, where do we start ? Grinding wheels, drills, taps, dies, milling cutters, lathe planer, and shaper tools. The developments in grinding wheels has long since got beyond me. It seems to me that for every grinding operation there are many types of grinding wheels available, and I am quite content to leave the problem to the grinding wheel expert whose one job in life is to make the best possible use of his product. We can but appreciate the great strides that have been and are being made. To me one of the most interesting grinding wheels is that using the annular grooves, crushed in by a hardened roller, for thread grinding. It seems all wrong but there it is doing its job. The results of the research work carried out by the makers of grinding wheels are known to us all, but what an interesting subject that research alone would be.

Drills, taps, dies, and so on, have all been influenced and greatly improved by the progressive developments in steel. The Taylor white steel was shown for the first time at the World's Exhibition at Paris in 1900. In 1910 the cobalt steel came on the market, and in 1929 the cemented tungsten carbide tools, with another enormous increase in the capacity of the tools.

Some few years ago the same twist drill was used to put a hole in any sort of material. We might vary the grinding of the drill

somewhat to meet different conditions. To-day, we have drills available for many different materials, and we know if we are to get the best results we should benefit by the research work carried on here.

Taps ground from the solid after hardening have made tapping a real production job, and now there is really no necessity to try to avoid it as much as possible. Whilst in England recently I saw these taps being used, ground with a sort of negative lead on the end for through holes, and with a positive lead on the end for blind holes, tapping malleable iron parts at speeds in excess of drilling speeds employed a few years ago. Some thousands of holes being tapped between grinds and tap breakages almost unknown.

As the modern machine tools are installed so are the tungsten carbide tools coming in to their own. For some idea of the research work involved in this group I can do no better than to refer you to that excellent paper "Cutting tools" by Dr. Schlesinger, which appeared in the February, 1939, issue of the *Journal* of the Institution of Production Engineers.

Supplies.

As the speeds of machines have increased and the range of manufactured moving machinery has extended, so also have the problems of lubrication increased, and the research worker in oils has been constantly on the job to keep abreast, or just ahead of these developments. Mineral oil, fish oil, vegetable oil, oil from shale, from coal, and so on.

What a field this covers. One of the most interesting developments in this field is the Houdry process, a method of producing high grade spirit from low grade crudes previously considered useless for this purpose.

Cutting compounds play an increasingly important part in these days of high production, and again a considerable amount of research work has produced satisfactory results.

Hardening compounds, methods of metal cleaning and plating, anodising and colour plating of aluminium parts, and many others one can list have all been improved and their sphere of usefulness extended as a result of research work.

Labour.

It may be thought somewhat strange for this to have been left till last. As a result of the labour of man we have all the many things we have dealt with, and we can now consider the effect of research on the human side of industry.

For the purpose of this paper let us subdivide labour as follows: (*a*) Management; (*b*) general productive labour.

Management.

It is generally accepted that F. W. Taylor in America was the first to set down rules and precepts for scientific production, while Henri Fayol in France did the same for the administrative side of the industrial problem.

Taylor's work is often referred to as "Scientific Management" and this has brought about the impression that he was the first to deal with management as a whole. However, his investigations dealt almost entirely with the practical side—works organisation, methods of payment, tool steels, etc., and he did not deal with the administrative side, or with the problems that are presented by an industrial undertaking as a whole.

Henri Fayol, on the other hand, while a practical man, was deeply interested in administrative problems. He left behind him a partially completed work on administration, which shows a penetrating mind and a very wide grasp of the need for dividing management responsibilities into the specific functions in which they arise. He divided the functions of management into: Technical, commercial, financial, security, accounting, and administration.

To-day it is customary to accept management as having six functional sub-divisions: Production, distribution, development, accounts and finance, legal and secretarial, personnel and industrial relations.

We see everywhere in industry, a new consciousness of managements' responsibility towards their personnel as well as the realisation that healthy employees, safe and hygienic working conditions go hand in hand with economic production. The last war had a considerable influence on this matter in many ways.

Enormous quantities of war materials had to be produced; skilled men were scarce and considerable dilution of labour had to be effected to get the job done. Large numbers of women were employed in industries where only male labour had previously been used. This led to the introduction of such things as works' surgeries, rest rooms, canteens and so on. Critical investigation established the benefits obtained. Unskilled labour had to be used in place of skilled labour. What had been safe enough in the hands of the skilled operative was certainly not safe when used by the unskilled. Consequently injuries were frequent and much production, so urgently needed, was lost. Research work again was carried out and considerable progress was made in establishing safer working conditions for operatives with a consequent reduction in "stand off" time and increase in production.

Prior to that time executives had at their disposal any amount of skilled labour—every man knowing his job thoroughly, so much so that management had become too easy and it was only when

this skilled labour was either not available or swamped by the unskilled, that management began to realise how much had been left in the hands of the old employees and in effect, how little real management had been put into their works. They had to get far more on top of the job than they had been previously, and soon realised that men and women called on to perform unfamiliar tasks suffered from fatigue, eye strain, skin diseases—occupational dermatitis and many other things which had the effect of slowing down production. Obviously some way to overcome this had to be found. By careful inquiry and investigation it was found. By so doing they not only performed humanitarian work but gave a considerable boost to production.

Those days were not forgotten and the work carried out formed an excellent foundation for further work and generally, one might say, was the beginning of scientific management.

For years this investigation has been going on in all parts of the world and some years ago an International Management Congress was started. In the December, 1938, issue of *The Journal* we had a report on the Seventh International Congress held in America. From this report I should like to quote the following :—

"Management is everyman's concern since it occupies a key position in the process of providing society with what it desires. Karl T. Compton, President of the Massachusetts Institute of Technology, outlined the vital role of management when he said : '. . . The unemployed want work, industry wants profits, agriculture wants new uses for its products, natural resources ought to be more wisely used, national hazards should be curtailed. labour wants shorter hours and higher pay ; all the people want more wealth, lower income taxes, better health and comfort, additional facilities and commodities. Every one of these desirable social developments can only be realised through the action of two forces, the force of better technical developments and the force of better management.' The idea of management becomes concrete when it is viewed as the effort to link workers and machines together so as to achieve for all both a higher standard of living and a greater measure of security.

"The General Sessions of the Congress emphasised that management is now envisaged more clearly as a separate function ; that it is becoming more human and is demonstrably more alert to its social responsibilities ; that those in positions of responsibility are by no means content with their achievements, being inclined to look forward for new opportunities rather than backwards to what has been accomplished ; that they are more sensitive to public opinion than at any previous time ; and that in the task of achieving a progressive and stable society, management occupies a key position."

Points of interest in the field of production management are also taken from that report :—

"Industrial research should more nearly approach scientific research, in that the results should not be kept secret, but made available to all.

"The idea of preventing as much as possible the more serious fluctuation in the productive process by providing the following : (*a*) A greater operator versatility, with workers able to do more than one job ; (*b*) increased preparedness for fluctuations through more flexible budgets and other controls ; (*c*) provision against seasonal fluctuations by the development of fill-in products and added storage space.

"Approval of decentralisation idea.

"The changed managerial attitude to : (*a*) The suppliers—the people who sell to manufacturers. The purchasing agents are learning that the salesman can aid in the whole process of purchasing and manufacturing ; (*b*) more thinking by those engaged in the productive processes about the consumer, and the *why* of the thing they are making."

In a paper of this kind no attempt can be made to deal in detail with the research work of management and the foregoing remarks can only bring before you the fact we just cannot get away from what we know as research—consciously or unconsciously, in one way or another, we are all engaged in it. Management must shoulder the full responsibility of that which it controls.

General Productive Labour.

One English writer on factory life said : "As a nation we count not the cost in money to get the highest quality in rearing animals, such as sheep, horses and dogs ; yet the human being, that is the worker and his family, who are really the backbone of the nation, is almost forgotten."

There may be some measure of truth in this, but recently I spent some time going through the two volumes of "Occupation and Health," an encyclopaedia of hygiene, pathology and social welfare, published by the International Labour Office, Geneva, 1930 and 1934, and from these, more than from any other source, I think, one gets a small appreciation of what has been done by research workers in all parts of the world—I say small because the work is so vast that it is quite impossible to appreciate fully the amount of work done.

The introduction to this encyclopaedia bears a motto which translated reads : "The duty of a doctor attending the common people is to inquire what trade they practice."

There are numerous sources of disease which do not affect the privileged classes of society, but only that class which St. Simon

called " the most numerous and the poorest," and which nevertheless by its work gives rise to all wealth, all progress and all happiness. For a long time this work, which is indispensable to the prosperity of the community, brought the worker nothing but physical, intellectual and moral poverty.

In ancient societies, dangerous and disagreeable tasks were reserved for criminals, then " small gangs " were used for these tasks, but nowadays modern society realises that occupational diseases should not be reserved for certain persons, but that they should be made to disappear and as one writer puts it : " Life must be preserved for labour, and labour must be made harmless to life."

A tremendous amount of research has been carried out with this in view with a consequent increase in productive capacity. Australia has in no way lagged behind other countries, in fact, in many ways one can say that it has given a lead to older and more industrial developed countries.

Factory legislation exercises considerable influence over the conditions prevailing in industry to-day, but a far greater influence is that of management's changed outlook to labour, and its realisation that safe and healthy working conditions do favourably affect production.

The first factory legislation we have record of was passed in Great Britain in 1802 and was known as the " Health and Morals of Apprentices Act," passed to safeguard the poor parish apprentices in the textile industry of Lancashire, who were transferred from workhouses to factories, and from what one reads of conditions prevailing at that time, some such Act was badly needed. This and other Acts which followed, were so successful that employers who had previously opposed them, soon found they were beneficial to their interests as well as to those employed.

The last Act in Great Britain was that of 1937, which came into force after considerable research and which, in spite of some criticism, represented conditions prevailing in the best managed factories, and its demands were, therefore, not pious hope, but in many cases accomplished fact.

All this goes a certain distance, but much as can be taken care in the factories there remains one very important matter which fortunately is taken care of in this country, but not in many others ; that is, for any labourer in industry to maintain a state of health to permit him to carry out his daily task, he must in return for his labour have sufficient cash return to enable him to purchase the necessities of life for himself, wife and family. A living wage. Without this he can but be a weak link in the chain of production. In this country considerable research work is being done constantly to determine this living wage.

Now, having taken steps to provide the labourer with sufficient nourishment to fit him for his task, provided safe and healthy working conditions under which to carry it out, what next? Is it not true that we pay the closest attention to our machines, materials, supplies and so on, and often little to the man who has the handling of all of them? Let me quote once again from the Report of the Seventh International Management Congress, I.P.E. Journal, December, 1938:—

"The practical handling of human affairs involves a sphere of action where science, although it remains man's only source of information, is not of itself sufficient for the solution of the problems encountered.

"The conscious training of those who are going to hold administrative and managerial posts thus emerges as a factor of enhanced importance and becomes increasingly a matter of acquiring an art in addition to learning a technique. Training in those sciences which have contributed to the creation of a new industrial order remains a necessity but is no longer sufficient in itself. Additional practice is required in human and social investigations and in the habit of human responsibility.

"It was realised that the qualities required for leadership could not be obtained merely by the provision of special courses; that character and personality are qualities which require suitable background and environment to develop, and that it should be the personal duty of the present leaders in industry to train their successors by contact and influence. It was felt that this personal training by example could do more than any other single factor to ensure that the latent talents of the leaders are brought to fruition. From the point of view of the employee, this awakened consciousness of the human aspects of management was to be seen in discussions centring round the tendency for management to conform the process to the men rather than the man to the process.

"In discussing the relationship of management to the employee, the employee was seen as a co-ordinate human being and it was recognised as desirable to have the employee become more money conscious, to have him thinking about doing things as cheaply as possible and to develop in him a consumer consciousness. Serious attempts were also being made to assess on a scientific basis the reward appropriate to skill, service, reliability, initiative, and all the other factors which are made use of in doing a job. It was felt that something further than the normal working of the laws of supply and demand and collective bargaining was required, and the problem was considered to be a subject for early research."

What a field for research! If we as production engineers all play our part as efficiently as we must in the difficult days ahead,

then we must face up to the necessary research work on the human side of industry.

The Research Department of the Institution of Production Engineers.

The following appeared in "Machinery," January 5, 1939, and was reprinted by arrangement in the Journal :—

"The research Department of the Institution of Production Engineers was officially brought into operation on January 2, this year thus inaugurating a project the need of which has long been felt in production engineering circles. The new department has been placed under the direction of Dr. Georg Schlesinger, an expert of world renown in production research.

"Dr. Schlesinger has been responsible for the layout of many modern factories in Germany, Russia, and other countries, and among other work assisted the Russian Government in the planning of their production research department where between 1,100 and 1,200 people find constant employment. Although in this country Dr. Schlesinger is perhaps best known for his work in connection with machine tool tests and alignments, there is no aspect of modern production with which he is not familiar, and the new laboratory will be concerned with a wide range of problems bearing on production in its broader aspects.

"The necessary accommodation for the Department's laboratory has been provided by the Loughborough College, and it is understood that some of the senior students of the College will be seconded to help Dr. Schelsinger. Although the research activities will thus be centred at Loughborough, some of the important work will be done at various factories in different parts of the country. There are, of course, many aspects of production which cannot be studied adequately in a laboratory, however well equipped. Problems relating to the handling of work, the economics of fine finish, industrial safety, and planning and processing, are for example, matters which require the co-operation of factory executives. In addition to the co-operation of factories, it is hoped that assistance in specific research work will be obtained from various colleges and universities throughout the country, where suitable equipment is available, and also that co-operation with other engineering institutions will be possible.

"Among the subjects suggested for research may be mentioned the materials and tools used in cold forming ; the standardisation of surface finish and its measurement ; the effect of vibration on productive efficiency ; machine guards and the possibility of their standardisation ; modern cutting alloys, and cutting fluids. It also seems likely that the standardisation of machine tool tests and alignments is a matter to which attention will be given at an

early date, while the design of machine tools from the user's point of view is a subject which may also be considered. In connection with the design of machine tools, useful research may be conducted to compare ground slides with scraped slides, and hardened steel ways with ways which have been machined from the chilled casting.

" Summarised, the aims of the new research laboratory will be to assist the engineering designer to give a better and cheaper product. An example will perhaps serve to indicate the importance to the designer of production research.

" The designs for a highly successful type of radial sleeve valve aero-engine were completed some time before production could be commenced, as the manufacture of some of the important components entailed intensive investigation from the standpoint of production. Not until special production equipment and methods had been perfected, was it possible to proceed with manufacture on a production basis.

" A scheme of the magnitude of that envisaged by the Institution of Production Engineers will, of course, require funds. The generous gift of £25,000 by Lord Nuffield, President of the Institution, provides a useful beginning, but it is understood that an income of something like £10,000 per annum will be needed before the Department of Scientific and Industrial Research would agree to give a large annual grant. The Institution has decided to hand over to its research department 80% of the annual subscriptions it receives from its affiliated firms. In addition, it will have to look to the engineering industries of this country for liberal financial backing."

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

Introduction.

It is proposed to publish every month abstracts from the technical press of this and other countries, including America, France, and Germany.

The abstracts will be printed on alternate pages so as to allow of their being cut out and classified for reference purposes.

At present it is proposed to use the following forty-two classified headings :—

1.—Annealing, Casehardening, Tempering.
2.—Administration.
3.—Accounting, Cost Accounting.
4.—Belts and Ropes.
5.—Cinematics.
6.—Chemical Processes.
7.—Compressed Air.
8.—Coolant, Lubricant.
9.—Electrical Engineering.
10.—Employees and Workmen.
11.—Heating, Ventilation.
12.—Foundry Moulding.
13.—Gearing.
14.—History.
15.—Jigs and Fixtures.
16.—Lighting.
17.—Machine Components.
18.—Machining Metals (cold) ;
Processes in general :—
(*a*) lathe.
(*b*) turret lathe.
(*c*) auto. screw machine.
(*d*) drilling, boring, reaming.
(*e*) thread cutting.
(*f*) grinding.
(*g*) polishing, lapping, honing.
(*h*) planing, shaping, slotting, broaching.
(*i*) milling.
(*j*) gear cutting.
(*k*) sheet iron working.

19.—Machining Metals (hot); Forging, Pressing, Coining.
20.—Management.
21.—Materials, material testing.
22.—Measuring Methods, Apparatus.
23.—Mechanics.
24.—Metallurgy of Steel.
25.—Physics.
26.—Photography (Film, Moving Pictures).
27.—Plastic Material.
28.—Power, Drive.
29.—Psychological Investigation.
30.—Retailing.
31.—Shop and Shop Management.
32.—Small Tools;
    (*a*) measuring.
    (*b*) cutting.
33.—Standardisation.
34.—Stone Machining.
35.—Surface Treatment.
36.—Technical Education.
37.—Technical Information.
38.—Transport and Transport Equipment.
39.—Tubes, Fittings, etc.
40.—Welding, Brazing.
41.—Works and Plant.
42.—Woodworking.

ANNEALING, CASEHARDENING, TEMPERING.

The Hardening of Steel, by J. M. Pethebridge, Metals Treatment Soc. of Victoria. (*Australasian Engineer, Vol. 38, No. 266—July, 1938, p. 12, 6 figs. Cont. from No. 265.*)

The article shows structures developed by quenching, then what occurs in the quench, gives details of the effects of various elements and toughness and some information of the division of the cooling process into three stages, distinguished by the mode of heat and stir from the surface of the steel to the surrounding quenching medium. First stage : a continuous vapour blanket formed around the piece being quenched, the rate of cooling of the surface is dependent on the conductivity of this vapour. Second stage : the continuous vapour blanket is dispersed, cold liquid is coming into contact with the surface. Third stage : no vapour is formed, the quenching medium carries heat away from the surface by convection alone (illustrations).

COST ACCOUNTING.

Factory Costing, by F. E. L. Weaver. Inst. of Cost and Works Accounts. (*Trans. of the Inst., Vol. 18, No. 8—January, 1939, p. 244*).

Study of the growth of railroads with reference to the permanent way. The aim is to keep full and true accounts, double entry system : (1) Receipts and Expenditure on Capital Account. (2) A General Balance Sheet. (3) Revenue Receipts and Expenditure of the whole undertaking : Railway, Road Transport, Steam Boats, Canals, Docks, Harbours and Wharves, etc., with regard to the actual manufacture of switches and crossings we have : the Layout of Shops, Wages Factor, Handling, Overheads, Co-ordination of Foundry and Machine Shop, Dates of Delivery, Office Co-ordination.

The workers are placed in groups, as they are ordinarily found in all machine shops : direct labour and indirect labour. The departments comprise : marking off, sawing, drilling, planing, shaping, setting, smithing, assembling. Shortly the author brings a review of the fundamental rules of administration to railway shops.

CINEMATICS.

Mechanism for Automatically Indexing Work-table and Feeding a Drill. (*Machinery, Vol. 53, No. 1371—19 January, 1939, p. 505, 1 fig.*).

Drawing and its explanation.

HEATING, VENTILATION.

Central Air Conditioning in Works and Factories, by B. C. Oldham, Inst. of Production Engineers. (*Industrial Power, Vol. 14, No. 159—December, 1938, p. 437, 4 figs*).

The vital influence of humidity. Composition of air. Air calculation. Central heating. Central air conditioning, dehumidification. Damage of steel. Rigid control needed.

FOUNDRY MOULDING.

Ou en est la Coulee Centrifuge. (*La Revue de Fonderie Moderne, XXXIIIe Année—January, 1939, p. 1, 6 figs.*).

Advantages of founding by centrifugal power in the technique of the foundry. Increase in the quality of material. Characteristic comparisons of some alloys. Type of machines for centrifugal casting. Tubes of cast iron. The three principal types of centrifugal casting machines. Tubes of steel. Tubes of non-ferrous metals. Procedure of Briede-de-Lavaud. Casting machine for multiple moulds. Applications.

GEARING.

A Chart for Pitch Selection of Bevel Gears, by E. G. Fiegehen. (*Mechanical World, Vol. 105, No. 2715—13 January, 1939, p. 35, 2 figs.*).

The author refers to the calculation of spur pinions, following the requirements of British Standards Specification No. 436, and applies the basic factors in this specification to the determination of the capacity of bevel gearing, provided that due allowance is made for the effects of the geometric form of this type of gearing. The author gives the essentials of a bevel gear, and concludes his article with a chart for pitch selection of bevel gears. For this purpose he used the B.S.I. formula for wear value.

HEAT.

Gas-fired Furnaces, by J. D. Watson. (*Fuel Economist, Vol. 14, No. 153—June, 1938, p. 205, 7 figs.*).

The gas furnace is not an appliance of general utility, but only for special application. If a suitable equipment is given the heat in a gas fired furnace is excellently controlable. Fuel is clean and scale forming is obviated. With automatic regulation operating cost of modern gas furnace is low, especially in consideration of labour and wastage saving. Examples. Wellman gas-fired pot furnace, oven type gas furnace, with surface combustion burner, small pot furnace, gas-fired furnace arrangement of tunnel and impact burners control, velocity burner and two-stage high pressure burner. Gas firing from the roof.

Seven Types of Gas Heating for Works with Temperature Problems. (*Industrial Power, Vol. 14, No. 159—December, 1938, p. 414. 10 figs.*).

(1) Hot water pipes. (2) Convection heaters. (3) Central air heating. (4) Unit air heaters. (5) Self-contained air heaters. (6) Radiant vitreous panel. (7) Radiant refractory panel. Due attention ought to be paid to guaranteed heating capacities of the various types of heating equipment. This must be done with regard to the actual structure of the existing equipment, or a new one, especially the capacity figures must be noted.

JIGS AND FIXTURES.

Circular Division, by K. J. Hume. (*Machinery, Vol. 53, No. 1368—29 December, 1938, p. 393. 2 figs.*).

Influence of incorrect alignment of dividing head and loose head axis. The effect of the form of coupling on accuracy.

MACHINE COMPONENTS.

Calculations for Determining the Dimensions of Bearings for Internal Combustion Engines. (*Ball Bearing Journal* [*Shefko*], *No. 2, 1938, p. 18. 5 figs.*).

How to find the probable life of a bearing operating under variable loads. Determination of the equivalent continuous load. Formula combines cubic main pressure, explosion pressure and a factor depending on the relation between the acceleration forces and the explosion pressure. Graphs for the different relative factors. Calculation formulas for main bearings. Examples of main and big end bearings of single cylinder semi-Diesel engine.

Transmission of Torque by Keys and Keyways, by W. H. H. Gibson and P. M. Gilet. Inst. of Engineers, Australia. (*Trans. of the Inst., Vol. 10, No. 11—November, 1938, p. 393. 10 figs. Part I and II*).

The paper describes researches on the action of keys in transmitting torque carried out by the author in the research laboratory, University of Sydney.

Stress distribution and frictional effects were studied by photo-elastic methods with the aid of cinematography. An analysis of the action into its elastic and frictional parts is given. In Part II of the paper this analysis will be developed and applied to the interpretation of experimental results obtained by cyclic torsion tests on a steel model. Factors are given for the concentration of shear-stress and bearing pressure.

Eignung von Waelzlagern fuer sehr grosse Belastungen, by Dr. Fng. Hans Meyer. (*VDI Zeitschrift, Bd. 83, Nr. 4. 28 Jan., 1939, p. 99. 12 figs.*).

Samples from smelting works : replacing very highly loaded plain bearings by roller bearings. Advantages : very low wear, no attendance, less energy, less lubricant up to 90%, greater safety. Designs of rolling mills, gear boxes, transporting cars, locomotives, travelling cranes. Economy, savings.

MACHINING METALS (COLD) GENERAL

The Manufacture of Anti-aircraft Guns. (*Machinery, Vol. 53, No. 1370—January 12, 1939, p. 445, 38 figs.*).

Plenty of illustrations of the specialised plant and the production methods at the Royal Ordnance Factory at Nottingham. Features of the factory, big special machines of all kinds, forgings for the loose liner, roughing before heat-treatment, machining after heat-treatment, tools, inspection equipment, special tools employed for the chambering operations, rifling tools.

Machining 3.7 in. barrel jackets at the Royal Ordnance Factory. Step-boring operations, taper boring, special honing tool for finishing the tapered bore, turning, facing and screwing for the breech-ring, milling the interruptions in the buttress thread.

The Production of Steel Manifolds and Cowlings. (*Machinery, Vol. 53, No. 1368—December 29, 1938, p. 385, 19 Figs.*).

Methods employed at the new Rodney Works of the Bristol Aeroplane Co. Ltd. Pressing, rivetting, the front exhaust manifold, inspection jigs, assembly. Bending machine, welding jigs, stretching presses, drilling and final assembly jigs.

SHEET IRON WORKING

Les avantages d'une machine a plier moderne. (*La Machine Moderne, No. 365, XXXIIe Année—December, 1938, p. 784, 24 figs.*).

Bending machine performing all necessary operations. The articles illustrate the action of the bending beam, its horizontal adjustment, the clamping of the sheet iron without screws, the rolling fixture, showing the design, the tools and their action in the different stages of performance.

Production Methods in Forming Double Curvature Sections for All Metal Aircraft, by A. J. T. Eyles. (*Sheet Metal Industries, Vol. 13, No. 141—January, 1939, p. 76, 14 figs.*).

In aircraft engineering the making of sheet-metal component parts often presents difficult problems as the number required is comparatively small. Steel punches and dies for blanking and forming operations are out of the question, because their cost would be far too high in proportion to the number of parts to be produced. Some very unusual methods have been devised by aircraft manufacturers to surmount these difficulties. The use of hand hammering is probably the oldest method for forming double curvatures or bulbous shape sheet-metal sections in all metal aircraft construction. Types of tools used for hand fabrication of panels are shown.

In all metal aircraft construction the tendency is towards the use of larger double curvature sections, which reduce the number of joints. The drop

hammer has particular merits in the quantity production of sheet-metal parts, although not applicable to sheets of large dimensions. The common practice is to make the upper die or punch of lead and the lower die of zinc. A more recent development is the use of cast Electron for die material in the drop hammer and power presses. The author describes further the German use of pressings and castings, and the spinning technique to form sheet metal to compound curvatures. The spinning speeds are given for aluminium forms. Finally, some data is published on the lubrication of the blank during the spinning operation.

MILLING

Installation and Operating Instructions for Parkinson Nos. 2j and 3j Plain and Universal Mills. (*British Machine Tool Engineering* [*A.B.M.T.M.*], *Vol. 20, No. 114, November-December, 1938, p. 294, 16 figs.*).

Erection drawings of the plane and universal milling machines, giving their general dimensions and capacity. The oiling diagram for the knee type milling machine. Section drawing through the main drive of the main spindle. Friction clutch and the method of its adjustment. Driving arrangements with chain drives.

GEAR CUTTING

Machine a tailler les engrenages adaptee a l'usinage successif des cames d'un arbre a cames. (*La Machine Moderne, No. 365, XXXIIe Année—December, 1938, p. 751, 9 figs.*).

Description of a mechanism which lifts automatically the workpiece, which is mounted on a Fellows Gear Shaper, permitting to cut six cams on the same mandril without dismounting.

GRINDING

Forming Screw Threads By Grinding, by S. J. Harley. (*Engineer, Vol. 167, No. 4333—January 27, 1939, p. 136, 7 figs.*).

Early historical survey. The new truing device wheel for grinding flanks and root radius of thread. Wheel for grinding crest radius of thread. Diamond truing by pantograph action of truing diamond. New technique for shouldered work type of crushers, details of production, single wheel operation, multi-ribbed wheels, tandem wheels, redressing, coolants, choice of wheels used.

The Bowgage Grinding Wheel-head Unit. (*Machinery, Vol. 53, No. 1370—January 12, 1939, p. 478, 3 figs.*).

A completely self-contained grinding wheel head unit, incorporating feed mechanism and automatic cycle control is of great value. It can be mounted in place of the standard wheel head unit on an existing machine, or built up on a special bed to meet requirements. The article shows a general view, a diagramatical section and a plan view of a machine incorporating one right and one left hand head, and illustrating typical applications of these units.

Tool Room Grinding. (*Machine Tool Review, Vol. 26, No. 167—November-December, 1938, p. 216, 11 Figs.*).

Some notes on the use of Norton grinding gears for sharpening saws, reamers, hobs, twist drills and taps.

LATHE

Lead Variation Device for Standard Lathes, by C. D. Mackinnon. (*Machinery Vol. 53, No. 1370—January 12, 1939, p. 466, 3 Figs.*).

Thread gauges have a high degree of accuracy. The pitch limit is ± 0.00025 in. This is much finer than the ordinary lead-screw lathe can perform. The

lathe in question was not good enough. It was decided to fit a new lead-screw and nut. The new lead-screw was finished at the N.P.L., but the results were disappointing and not better than from the former lead screw. Then the gears were ground, but the refinement was not sufficient. The same was done to the lathe spindle, saddle, lead screw bearings, but without complete success. The necessary correction was attained by a pitch variation device, described in the article by good sketch and its explanation. The arrangement has been in continuous operation for years and has given every satisfaction.

Trend of Design for Large Lathes—I and II, by J. H. Rivers. Manchester Association of Engineers. (*Machinist, Vol. 82, Nos. 50 and 51—January 21 and 28, 1939, 1pp. 672e and 490e, 10 figs.*).

Method of testing bed shears. Joints for screws and shafts. Screw cutting top slide of large lathe. Adjustable front bearing for spindle. Roller and angular contact bearings. Taper and parallel roller bearings. Adjustable bearings for spindle of tube boring machine.

MATERIALS, MATERIAL TESTING

Gewinnung, Eigenschaften und Verwendungsgebiete des elektrolytisch gelaeuterten Aluminiums, by H. Roehrig-Lautawerk. (*VDI-Zeitschrift-Bd-83—No. 1, January 7, 1939, 6 figs.*).

Aluminium of very high purity after three shifts-procedure of A. G. Betts. The fields open to this 99.99% pure metal, which, until now have been confined to other more expensive metals. The latest experience shows that here are still more fields for its application. Tensile, bending strengths, electrical qualities, physical coefficient, surface treatment, resistance against corrosion. Application : plating pressing, packing, high-polish.

The Working of Wrought Coppers and Brasses. *Machinist, Vol. 82, No. 50—January, 1939, 21. 1101, 6 figs.*).

Standard designations for rolled sheet and strip. Forms in which copper alloys commonly are available. Special brasses. Corrosion resistance. Hot working. Cold working. Annealing. Applications of typical coppers and copper-zinc alloys. Milling, grinding ; suggested wheels for grinding coppers and brasses. Cleaning. Soft soldering. Hard soldering. Brazing. Welding. Gas welding and carbon arc welding.

" Loded " Cast Irons, by H. J. Young. Inst. of Marine Engineers. (*Mechanical World, Vol. 105, No. 2716—January 20, 1939, p. 49, 16 figs.*).

A new range of high duty grey cast irons suitable for cylinder liners, pistons, rings and other important engineering castings, are known as " loded " irons. They may be manufactured with any normal iron foundry appliances, but metallographic control is essential. They form an extension of that group of machinable metals known as grey cast irons, made in metal moulds, stationary or moving. Their structure is all pearlitic. They are usable in the as-cast condition without heat treatment : effect of cooling rate, silicon control, chromium content, nickel and " loded " irons. At the end the author gives a condensed summary on the various qualities.

MEASURING METHODS, APPARATUS.

Draft Standard Specification for Toolmakers' Flats and High-precision Surface Plates. (*Machinery, Vol. 53, No. 1370—January 12, 1939, p. 471, 1 fig.*).

The British Standards Institution issued a draft British Standard Specification for Toolmakers' Flats and High-precision Surface Plates. Table I gives the

dimensions, Table 2 the limits of accuracy. An appendix furnishes the compositions of suitable steels for these flats and notes on appropriate methods of heat treatment. A second appendix recommends chemical composition of plain and alloy cast irons and methods of heat-treating them.

Another Draft Specification has been issued for steel straight edges of rectangular sections. Graphs show the deflection of a straightedge supported at the ends, at the centre, at the optimum points. The variation is between 0.0024 in. for the ends, and 0.00005 in. in the optimum points. This is a relation from 1 : 50. The article closes with a note on testing the accuracy of straightedges of rectangular sections.

Inspection by Projection, by F. L. Loewen. (*Machinist, Vol. 82, No. 51—January 28, 1939' p. 1147, 8 figs.*)

A number of conditions have to be fulfilled in order to produce the shadow image on a screen suitable for measuring purposes. Inaccurate focussing will create a double shadow and impair magnification. A diaphragm placed between the lens and screen will stop the rays that alter the size of the image. Distortion makes a straight line on the object appear curved on the screen. When a ground glass screen is used the observer's eye should be near the optical axis. A schematic sketch shows the layout of a projection system with transmitted light. Incident light as used in this system is preferable for certain objects. Edges accessible to the light rays are most suitable to projection by inspection. A parallel beam will not solve the problem. The objective lens needs rays with a certain aperture angle.

Measurement of the Thickness of Metal Plates from One Side, by A. G. Warren, Institution of Electrical Engineers. (*Trans. of the Inst., Vol. 84, No. 505, January, 1939, p. 91, 8 figs.*).

A method is described which is used for measuring the thickness of a metal plate, of which only one side is readily accessible. No knowledge of the conductivity or permeability of the material is presumed. The method is particularly applied to the determination of the extent of corrosion. The method consists of using the two dimensional flows of current. The current density due to one source is inversely proportional to the distance from the source ; the potential gradient is proportional to the current density. There follows a combination with the three dimensional flow of current, and then the application to the conditions in a plate of very fine thickness.

Measuring the Cutting Angles of Taps, by Dr. M. Kurrein. (*Machinist, Vol. 82, No. 51—January 28, 1939, p. 686e, 7 figs.*).

The author shows an apparatus to photograph tap angles A three-fluted tap is used. The measuring lines are drawn on tracing paper and compared on the photo. The same is made with a four-fluted tap.

METALLURGY OF STEEL.

Linien in der Entwickelung legierter Staehle, by E. Houdremont-Essen. (*Stahlu, Eisen H.1, Jan. 5, 1939, Vol. 59, 8 figs. Cont. H.2, Jan. 12, Vol. 59, 7 figs.*).

Experiments with fundamentals, laboratory tests, shop tests, pure experience—their influence on the development of the alloyed steels. Ordinary steels and those resistant to heat, influenced by tensile, etc., tests, which do not allow definite conclusions concerning the proof by actual use. Development of tool steels based on experience and shop tests only ; later by experiments with short-trials. Proportion of materials with special physical qualities. Creation of different steels of great resistance against corrosion

on the basis of laboratory tests and confirmation by experience. Crankshafts of aeroplanes. Crankpins of chrome-nickel-molybdenum steel. Ordinary steels. Non-rusting steels.

PLASTIC MATERIALS.

Plastic Materials, by A. Hessel Tiltman and A. E. Ellison. (*Aircraft Production, Vol. 1, No. 3—January, 1939, p. 79, 8 figs.*).

Reinforced synthetic resins. Some possible applications of plastics to the primary structure. The application of these compounds is still to be regarded as very experimental. Only few of those investigating possibilities have reached a sufficiently advanced stage to speak with certainty of the future. Examples are: Die-Moulded Structures, Laminated Resin Structures, Mechanical Joints. The author treats the question of bonding and illustrates graphs of tensile stress-strain curve for cord-reinforced resin, and changes for use in the compressive stress-strain curve by the addition of a cord-reinforcing material. The elastic modulus reaches a maximum value at 6,000 lb. per sq. in.

PSYCHOLOGICAL INVESTIGATION.

To What Extent is the Health of Industrial Workers Dependent on Occupation? by Dr. H. M. Vernon. (*Occupational Psychology* [*Nat. Inst. of Industrial Psychology*], *Vol. 13, No. 1—January, 1939, p. 10,*)

The author begins by discussing the direct effects of occupation on the health of industrial workers, and discusses briefly the results of inhaling various dusts and fumes, of exposure to irritants of the skin and to accident risk. Further briefly less clear cut cases, in which health is affected by the high temperatures and humidity peculiar to certain industries. The author then considers the importance of the social environment. (Nutrition, heredity, inheritance of certain diseases and of intelligence).

SHOP AND SHOP MANAGEMENT ECONOMY

Instandhalten von Werkzeugmaschinen, by H. Grueber-Betrieb-Bd. 18, *H½—January, 1939, p. 7, 8 Figs.*).

Influence of installation on life of machines, correct running, levelling, watching, maintenance, checking in fixed intervals, repair-department expenses about 5% of productive wages.

SURFACE TREATMENT

Heutiger Stand des Emaillierens von Stahl und Gusseisen, by L. Faulhaber-Duisburg Stahl und Eisen. H. (*January 15, 1939, Vol. 59*).

Influence of chemical components of the basic material on the possibility of enamelling. Importance of the structure of the main material for the adhesion of the enamel. Preparation of the base material for enamelling. Composition of primary and cover enamel. Conditions of burning and installations. Errors Qualities and range of application for enamelled steel and cast iron.

Chemical Pre-treatment Process for Ferrous Metals, by E. E. Halls. (*Machinery, Vol. 53, No. 1368—December 29, 1938, p. 397, 1 Fig.*).

Corrosion resistant, paint finishes. The phosphate pre-treatment processes. Advantages and disadvantages of blasting. Chemical pre-treatment by phosphate processes. Disadvantage of phosphate processes.

WELDING, BRAZING

Organising and Managing a Job Shop, by L. T. Duff. (*Welding Industry, Vol. 6, No. 12—January, 1939, p. 410*).

The author describes at first equipment necessary to run a job shop which specialises in welding affairs. Of course, according to the nature of the job various machine tools would be required too. Lathes, milling machine, drilling machine and probably a horizontal boring machine, with the necessary tools for each machine. A testing bench, with testing plates, bolts and studs for blanking off water holes and then testing with water. A water pump and lifting tackle. A detailed description of the welding equipment is given. General rules are given on care of equipment, hiring, training and managing the men. Training the welder. Care of men, first aid, etc. Testing of work. Time and pay. Night staff. Controlling the men. Transport. Stores. Getting business through advertising. Booklets. Personal calls, contacts, etc. Keeping costs and costs records. Pricing the work. Invoicing. Accounts.

Some Experimental Welding on the Burma Railways, by C. B. Hayes. (*Electric Welding [Quasi-Arc], Vol. 8, No. 44, December, 1938, p. 50, 15 figs.*).

The rail joints of the ordinary type with screws and nuts shall be replaced by arc-welded joints. The type of joint was a butt-welded head with a channel section sole plate welded to the rail foot, the web and rail foot at the joint being unwelded. The life and the success depended on the shape of the weld fillet. There must be sufficient penetration. These welds have now been on the track for eight months with no sign of failure, being used by the heaviest locomotives on the system. Neither has there been any trouble with buckling in spite of a large temperature variation. Similar good results have been made with the standard switches.

The Design of Welded Structures, by G. Roberts, Inst. of Welding. (*Welding Industry, Vol. 6, No. 12—January, 1939, p. 438, 9 figs.*).

Welding procedure. Butt-welds. Strength of welds. Working stresses. Contraction and distortion. Design of connections : beams and columns. Plate girders. Design of crane girders. Design of heavy plate girder. Rigid frame construction. Lattice girders. Bridge floors. Economy in welding. As appendix, the calculations for a rigid frame.

Welded Construction versus Cast Iron for Machine Tools—I, by A. Kershaw. (*Machinist, Vol. 82, No. 50—January 21, 1939, p. 677e*).

The organisation of a design. Concealed posts. Founding limits. Material stock. Weight reduction. Machining the material.

Automatic Arc-Welding Machine for Boiler Drums. (*Engineering, Vol. 147, No. 3808—January 6, 1939, p. 28, 5 figs.*).

The essential components of the machine are a work bed on which the cylindrical drums to be welded are placed, two travelling tunnels which carry the welding heads and the components. The control gear, which is housed in a sheet steel cubicle at the back of the machine ; transformers, reactors, motor generator, driving motors, as well as the mechanical design of the machine, are designed by Metropolitan Vickers Electrical Co., Manchester. The bed is approximately 50 ft. long. The rollers are mounted on cross slides, which enable the distance between two rollers forming a pair to be varied from 1 ft. 6 in. to 11 ft. in diameter of the piece. The motor drive gives a welding speed range from 3 in. to 18 in. per minute. All the motors are supplied by a 15 kw. motor generator set.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ADMINISTRATION.

Job Evaluation, by J. E. Walters. *(Mechanical Engineering, Vol. 60, No. 12—December, 38, p. 921, 6 figs. Parts I and II).*

An analysis of the several plans in use to-day. Occupational classification or reclassification. The informal plans of job evaluation. The grading system of job evaluation. The point system of job evaluation. Charts of daily earnings and classifications. Points assigned to factors and key to grades. Summary of job requirements. Job characteristics and weights. Guide chart for determining mental-effort factor. Job rating sheet. After reviewing the job evaluation plans of 32 companies and because of the fact that about twice as many of the companies have the point system as those who have the ranking system, it is the opinion of the author that the point system is better than the ranking system, or the informal comparison to community rates. Job rating chart. Job evaluation is one of the newer tools of scientific management and, like time study, production control, plant layout, and many others it is evolutionary. Functions of job evaluation. Cost of job evaluation. Description of system used. Description of jobs. Point-rating plan. Approval of established grades. Maintenance of system.

GEARING.

Worm Gears—III, by A. B. White. *(Power Transmission, February, 15 1939, Vol. 8, No. 85, p. 12, fig. 4).*

The general condition of worm gear contact is analogous with a rack and pinion. Pitch point contact is obtained at which rolling motion occurs, and throughout contact a continuous sliding motion exists between worm and wheel.

The splash oiling method is generally adopted for worm gears for all general duties. The splash system is not so efficient in the case of overtype gears, since it depends for its success upon the ability of the wheel to transfer the lubricant over relatively great distance at a low velocity. A circulating system is therefore often fitted to large power high-speed overtype gears.

The principal forces to be determined when calculating bearing loads on worm and wheel shafts are shown and the end formula between end thrust, horsepower, revolutions/min. and diameter is developed. The resultant loads on the worm-bearings and wheelshaft-bearings are calculated.

LIGHTING.

Lighting Maintenance is not just the Cost of the Lamps, by F. W. Mounter. *(Industrial Power, Vol. XV, No. 160—January, 1939, p. 25).*

When replacements may cost £2 each. Test figures of losses in light output resulting from normal accumulation of dirt and dust on electrical fittings, walls, and ceilings. Typical office installation of opal spherical diffusing units;

total loss of light . . . 35%. Typical factory lighting installation of standard dispersing reflectors; total loss of light . . . 23%. Add to the above figures approximately 8% loss of efficiency from the light source itself, which may have passed its efficient life period of 1,000 hours. Meaning of "maintenance." The installation itself should be so designed that complete and regular maintenance is possible economically by the regular maintenance staff under ordnary working conditions. Where the operatives are working on a piece-work basis, they will endeavour to finish their quotas by working on when a lamp fails, rather than waste time looking for the maintenance man. It is on such occasions that accidents occur. It is then the employer who runs the risk. The group replacement system is the only way to keep down maintenance costs on large installations. Cover glasses represent a first class maintenance facility, and they commend themselves for those positions where it is too difficult to fulfil the requirements of accessibility. Maintenance requires a certain amount of organisation. The maintenance of lighting installations should be a definite job handed over to a certain person, who should be provided with a ruled book with columns headed "Positions of installation," "Type and number of fittings," and "Foot-candles of illumination," the latter being sub-headed "Before cleaning" and "After cleaning."

MACHINE COMPONENTS.

La rigidite des bancs de machines-outils, by F. Koenigsberger. (*Machine Moderne, February, 1939, Vol. 33, No. 367, p. 63, 3 figs*).

Comparison of the rigidity of beds either made in cast iron or by fabricated constructions specially for the beds. Characteristics of a lathe bed. Development of very interesting graphs to avoid complicated calculations. First graph to find the weight, the rigidity, and the critical period. If one knows the specific weight of the material, its modul of elasticity, and the volume; second graph giving the relations of the main dimensions of the lathe. Examples.

Transmission of Torque by Keys and Keyways—Part II, by W. H. Gibson and P. M. Gilet. (*The Journal of the Institution of Engineers, Australia, December, 1938, Vol. 10, No. 12, p. 427, 6 figs.*).

Effects of length. Diagram illustrating the hypothesis of "Boundary deformation" in the frictional transmission of torque.

Experiments with steel models, showing the adaptation of the Martens extensometers for the measurement of twist. Hysteresis loops of torque and twist, limiting cases, analysis of experimental loops, lengthwise distribution of the key loading and shaft torque, summary results.

Walzenzapfenlager aus Kunstharz-Presstoffen, by J. Arens. (*Stahl und Eisen, Vol. 59, No. 8, February 23, 1939, p. 213, 26 figs.*).

Interesting trial to replace the well proved bronze or white-metal bearings by such of "resin" as "Ersatstoff." The chemical bases are phenol and creosol combined with textiles as fillers. These bearings are sensitive against heavy blows, radiating heat, high temperatures in the bearing, very great pressures, and long continuous working time. Another material demands a new design. The essential feature is their cheapness; consider a plain bearing of 24 in. ϕ ! The qualities of the resin-bearing materials are given, their most economic design, coolant and lubrication, further examples on long lasting (two to three years) experience in big rolling mills.

MACHINING METALS (COLD)—GENERAL.

Hydraulic Machine Tools, Annual Meeting. A.S.M.E. (*Mechanical Engineering, Vol. 61, No. 2, p. 165, fig. 2*).

In order to get a direct comparison of the benefit of hydraulic drive over a mechanical type, a recording device with a revolving-drum driven at a peripheral speed of 168 in. per minute was made. This device was mounted on the shaper table and, with a pencil on the tool post, made it possible to trace a ram-action diagram.

Hydraulic planer circuit diagram. Standard variable-delivery pumps are used. In the actual installation, the pump, motor, and tank are mounted in the bed and the cylinder is directly under the table in the rear half of the bed with its piston rod extending forward to a bracket which is attached to the front end of the table.

Trends in the Design of Heavy Machine Tools, by I. H. Rivers. (*Machinery, February 16, 1939, Vol. 53, No. 1375, p. 633, fig.8*).

The greatest influence on machine tool design during the last ten years has been the application of new cutting tool materials, and there has been a marked increase in cutting speeds. Other contributory causes have been the development of electrical equipment for use with machine tools, the availability of constructional materials of improved characteristics, particularly of gears, and the use of anti-friction bearings. Lathe beds, typical tongued joint for lead screw, adjustable plain front spindle bearing, self-aligning and parallel roller bearings used for a spindle mounting, an alternative mounting for a large-diameter hollow spindle using taper-bearings.

Werkzeugmaschinen auf der Technischen Messe zu Leipzig. (*VDi-Zeitschrift, Vol. 83, No. 8, February, 1939, p. 199-243*).

Reviews under the general standpoint : great precision, greatest speeds, best handling and service, perfect protection against accidents, nicely arranged working places.

(1) Report on lathes, turret lathe, automatic screw machines, by F. Twelsick, p. 198-209, 32 figs., some of them represent diagrammatic sections.

(2) Report on milling, drilling, planing, broaching, and grinding machines by H. Opitz and W. Vits, p. 210-216, 17 photo-illustrations.

(3) Report on sheet-forming machines by H. Kiekebusch, p. 217-223, 19 photo-illustrations. Special progress in designing such machines for a relatively small number of pieces. Feeding devices.

(4) Report on wood-working machinery by G. Pahlitzsch, p. 224-237, 28 figs., photo-illustration.

(5) Report on welding apparatus, by H. le Comte, p. 237-273, 18 figs., of gas and electric welding implements.

Werkzeugmaschinen im Kraftwagen, bau von Prof. Dr. Ing. Kienzle, (*Werkstattstechnik und Werksleiter, February 1, 1939. Vol. XXXIII, No. 3. p. 49*).

After a short introduction by *Kienzle*, detailed reports follow in I—machine tools for machining elements. II—by cold forming sheet iron.

Chapter I deals with special (German) machines for : (1) Motor block ; (2) piston, connecting rod, valves ; (3) crank and cam shafts ; (4) gears and spline shafts ; (5) rear and front axles and other round parts ; (6) hot-shaped elements ; (7) testing stands. Chapter II—dressing, cutting, bending, drawing, seaming sheets.

GEAR CUTTING.

The Production of Precision Gears for Use on Machine Tools, by I. Gordon. Lang. (*Engineering, February 3, 1939. Vol. CXLVII, No. 3812, p. 137*).

The ultimate success of a precision gear depends very largely on the material The material must be of a high tensile strength, high izod value, and hard surface. A very important consideration is that the material must not be prone to undue distortion during heat treatment. To fulfil these qualifications the materials best suited are nickel-chromium steel, oil hardened and tempered to 120 tons per square inch tensile strength, and nickel-chromium steel, case-hardened. All internal strains set up due to the working of the material should be completely released before the gear is ready for finish-machining, and careful consideration must be given to each different gear to determine at what stage the blank should be normalised. The accuracy of the bore and of one face, square and true to the bore, must be rigidly adhered to, and this face marked for future identification. The final operation, that of grinding the teeth, must be looked on more as a refinement than as a method of correcting preventable errors. The amount to be left for grinding must be kept as small as the accuracy of the dividing wheel of the gear-cutting machine, and the probable amount of distortion after heat treatment will allow, and should not be more than 0.006 in. With case-hardened gears it is desirable to harden the teeth only, and the remainder of the gear must be immunised before carbonising, or the carburised metal machined off after carburising. When the gear is finished the teeth are inspected for tooth contour, pitch error, cumulative errors, and pitch thickness. As a final check, a running test of the gear is made.

SHEET IRON WORKING.

A Welded Riveting Machine, by J. M. Baxter. (*Mechanical World. Vol. CIV, No. 2713, December 30, 1938, p. 634, 7 figs.*).

The welded machine designed for riveting, in a restricted space, the bulkhead frames of a ship's hull. Hydraulic pressure is applied to the ram of the jack to give the necessary force on the snaps for closing the rivet—in the present case 90,000 lb. Five illustrations show the welded construction. The weight of the welded machine is 8,400 lb. and the cost £185-16s. The time for delivery was three and a half months. The weight of the cast steel machine worked out at 9,500 lb. and the estimated cost £319-16s. The time for delivery was five months. In comparing the two types of machine the welded design has the following advantages : (1) The saving in cost of the welded design over the cast steel design is £134, i.e. £319 16s. less £185 16s., equals 42% ; (2) there is also a further saving in respect of the machining costs on castings which turn out defective ; (3) the welded machine can be designed more efficiently than the cast steel machine ; (4) there is complete freedom from sudden fracture in the welded machine ; (5) the welded design is lighter than the cast-steel design.

Die Verformungsvorgange beim Tiefziehen vom zylindrischen Hohlkörper bis zum unregelmassig formgestalteten Karosserieteil, von Göhre. (*Werkstattstechnik und Werksleiter, January 1 and February 15, 1939. Vol. XXXIII, No. 1/4, p. 5-105, figs. 27/22*).

Deep drawing beginning with the cylindrical shell to the irregularly shaped car-element. Fundamentals with illustrations of the processes. Cornered pieces, tapered pieces. Elements of the body, rolls, and shoulders ; uneven rims. Shape and dimensions of the strippers.

Machines et procédés d'émboutissage profond, by F. W. Simons. (*La Machine Moderne. Vol. 33, No. 366, January, 1939, p. 43, 13 figs.*).

Processes to form hollow bodies of sheet iron. Economic comparison. Fundamental deep drawing processes with the drawing-press. Press with raising table. Excenter-press. Press with cushion. Drawing without the sheet press. The kind of drive of the machine. The design of the cushions, hydraulic and pneumatic.

MATERIALS—MATERIAL TESTING.

Qualities and Applications of Beryllium Copper. (*Machinery Lloyd, Vol. XI, No. 2, January 28, 1939, p. 21, 9 figs.*).

Pure copper alone has, as is well known, low strength and resistance to permanent deformation. The addition of beryllium to copper in specific and controlled quantities results in a heat treatable or precipitation hardening metal with properties never before found in non-ferrous alloys. Micrographs showing the characteristic fine grain structure of the standard 2½% alloy of beryllium copper in the non-heat treated state. A simple heat treatment is sufficient to develop the maximum physical, mechanical, and electrical characteristics of beryllium copper alloys. In the heat treated state beryllium copper has a higher electrical and thermal conductivity than standard wrought bronzes and, in addition, ensures the retention of spring qualities under higher temperatures than other current conducting spring metals. Experience has proved that a standard alloy containing 2½% beryllium is the best for most applications. This standard alloy of beryllium copper is available in forms of sheet, strip, wire, rods, and blanks within certain limitations of size—minimum thickness or diameter about 0.005 in. (= 0.125 mm.), depending upon width, temper, or other conditions. It is usually supplied in the semi-hard cold worked form, suitable for fabrication and subsequent heat treatment. Applications—thermostatic control, non-magnetic qualities, helical springs, non-sparking tools, bearings, paper-making and textile machinery, spraying equipment, electric yield. Data on : Cold working, hot working, heat treatment, machining, soldering, plating, cleaning, or pickling.

MEASURING METHODS—APPARATUS.

Apparatus for Photo-elastic Experiment in Pure Torque, by P. Mathieu Gilet. (*The Journal of the Institution of Engineers*—Australia, *December, 1938. Vol. 10, No. 12, p. 433, fig.5*).

This paper describes two machines designed by the author and made in the Charles Kolling Mechanical Engineering Research Laboratory, University of Sidney, New South Wales, for experience in pure torque on photo-elastic models. Special provision has been made for recording variations in load and their effects by cinematography : Torsion machine, loading machine, coker apparatus.

Draft Standard Specification for Micrometers.. (*Machinery, Vol. 53, No. 1369, January 5, 1939, p. 432, 1 fig.*).

A draft British standard specification for micrometers has been prepared by the British Standards Institution, and copies are now being issued upon which those interested are invited to submit their comments to the Institution at 28, Victoria Street, London, S.W.1. The specification applies to micrometers having a bow-shaped frame holding a micrometer spindle on one side and an anvil on the other, and having a measuring range of 1 in. or 25 mm.

Gauging in Machine Tool Manufacture, by T. Curson. Institution of Mechanical Engineers. (*Machinery, Vol. 53, No. 1373. Februa 2, 1939, p. 562, 7 figs.*).

The author recommends the following table.

Set of gauges	Use	Allowance
		Inches
Gauge control room working set.	For use with Zeiss horizontal optimeter and orthotest.	—0.00002
Tool-room gauge inspection department set.	For checking gauges in course of manufacture.	—0.00003
Machine shop gauge stores set.	For observing condition of gauges after use.	—0.00005
General gauge maker's set.	For setting snap gauges, etc.	—0.00008
Final inspection for tools and fixtures set.	For checking gear centres, slots, etc.	—0.00010
Jig-boring department set.	For accurate setting of work tables.	—0.0002 up to
Fitting and grinding department set.	For jig setting and micrometer checking.	—0.0003

Examples are given for (1) Plain holes; (2) internal threads; (3) male and female tapers; (4) spline shafts and holes.

RESEARCH.

Science and Industry—No. I and II, The National Physical Laboratory. (*The Engineer, February 10 and 17, 1939, Vol. CLVII, No. 4335-6, p. 180-208*).

International standards. The investigation of the international temperature scale over the range 660° to 1063°C. has been completed. The results of the recent work on the absolute determinations of the principal electrical units have been presented to the International Committee of Weights and Measures.

Relations with industry. The number of routine tests of instruments and materials undertaken during the twelve months ended June 30, 1938, was about 41,500, exclusive of clinical thermometers and taximeters. Over the same period upwards of 530,000 clinical thermometers and over 20,000 taximeters were tested.

Physical department. Determinations of the thermal conductivities of a number of gases, liquids, and solids have been continued. The substances investigated have included air, carbon dioxide, liquid and gaseous refrigerants mica, oils used in the quenching steels.

In the *sound division* an investigation into the noise of motor horns, undertaken for the Ministry of Transport, has been completed. For the Institution of Automobile Engineers investigations are in progress relating to the silencing of motor cycles and to the reduction of drumming in motor car panels. Measurements have been made for the London Passenger Transport Board to assist in the lessening of noise in tube trains.

Metrology department. A new gauge interferometer has been brought into use, its purpose being the rapid and accurate standardisation of reference gauges to the highest precision. A number of gauges can be set up together in the apparatus and measured in sequence. An investigation has been made

into the cause of the local corrosion which sometimes occurs on the lapped surfaces of standard end gauges.

Engineering department. The fundamental research on the deformation and fracture of metals has been continued with the aid of precise methods of X-ray diffractions.

Metallurgy department. Progress has been made with the redetermination of the iron-carbon equilibrium diagram. The results of the investigation into the constitution of the alloys of nickel, chromium, and iron have been published.

Metallurgical research. Behaviour of materials at high temperatures. The mode of deformation of a number of materials is being studied in the vacuum creep units at various temperatures within the range 300° to 1,000°C. These materials consist of a series of high-carbon steels. Further attention has been given to the study of the influence of initial conditions on the creep behaviour of a low-carbon and a molybdenum steel.

Magnesium alloys. The study of the mechanical treatment giving the best results with forged magnesium alloys has been extended to a number of new compositions, and has also included rolled materials.

Internal stress. Experiments on the determination of internal stress were started.

Lubrification research. Four-ball high-pressure testing apparatus. The large number of mineral oils which have now been tested show considerable differences of behaviour. With a view to throwing light on the fundamental nature of wear and seizure some tests have been made with thin liquids like water and petrol. Typical lubricants have also been tested with bronze balls. Experiments are being carried out at continuously increasing loads, and at several operating speeds of the machine.

Physical properties of surfaces. A detailed analysis of the friction between moving metals has been carried out at Cambridge, and experiments show that the frictional force does not remain constant during sliding. The behaviour depends upon the relative physical properties of the sliding metals.

SMALL TOOLS.

Chip Breakers for Stellite Tools, by E. F. Smith. (*The Machinist, February 11, 1939, Vol. 83, No. 1, p. 10, fig. 5*).

Proper breaking and removal of chips is principally a problem of grinding the tool to suit governing conditions. A simple notch ground in the top of the tool often is all that is necessary for chip control. Other applications require a long, narrow groove. A modified groove, shown, gives increased lip strength. End cutting tools have a groove across the top. Since the edge is well supported, land can be narrower than for side cutting tools. Turning a nitralloy water pump shaft, bearing retainers from S.A.E. 6140 steel, boring S.A.E. 6135 steel bushing.

Le dessin et la construction des matrices, by C. R. Cory. (*Machine Moderne, February, 1939. Vol. 33, No. 367, p. 85, 7 figs.*).

Detailed design of progressive types to punch and to cut, to draw, and to coin.

Die Führung eines Schnittwerkzeuges, by K. Vogt. (*Betrieb, Vol. 18, heft 3/4. February, 1939, p. 67, 16 figs.*).

The most important part of the punching die is the guidance of the tool. Punch and die must be guided so that the cutting edges of both are never

damaged even with minimum play, mostly 0.01 mm. (0.0004 in.). Best design : Round ground and lapped columns, perfect production. Useful moulded zinc-alloys. Smallest fit : the hand-fitted posts of any shape.

SURFACE TREATMENT.

Hard-surfacing Processes and Materials, by M. L. Begeman. (*Mechanical Engineering, Vol. 60, No. 12. December, 1938, p. 931*).

Hard-surfacing is the process of applying to a wearing surface some metal or treatment which renders the surface highly resistant to abrasion. Such processes vary a great deal in their technique. Some apply a hard surface coating by fusion welding, while in others no material is added, and the surface metal is changed by heat-treatment or by contact with other materials. Carburizing, nitriding, chapmanizing, dry cyaniding, ni-carb process, induction hardening, flame hardening, metal spraying, metal plating, fusion-welding process. Diamond substitutes : The so-called " diamond substitutes " constitute the hardest materials that are available for hard surfacing. These materials are generally spoken of as cemented carbides, and include tungsten carbide, tantalum carbide, titanium carbide, boron carbide, and chromium boride, or a combination of these and other carbides with a suitable cementing agent.

Lapping, by F. W. Shaw. (*Machinery, Vol. 53, No. 1373, February 2, 1939, p. 559, 4 figs.*).

Its influence on the durability and efficiency of co-acting metal surfaces. The abrasive before and after use. Wear tests of lapped surfaces. Efficiency tests of lapped surfaces. Wear graphs indicate that abrasive, if present, had no appreciable effect on bronze run for twenty five hours with mild steel ; that white-metal, whether run with lapped or unlapped mild steel loses equal weight in 100 hours ; that lapping accelerates the running-in or surface conditioning process (white metal with steel only). Friction graphs indicate that, whether the specimens or the test discs are lapped or not, after either a ten hour or a twenty hour run, the co-efficient of friction is substantially the same. No increase of friction was registered when the load was increased four-fold at ten hours.

Metal Spraying, by J. A. Oates. (*Aircraft Production, Vol. 1, No. 4. February, 1939, p. 117, 8 figs.*).

Various applications in the aircraft industry. Two main uses : protection of surfaces and building up worn parts. After exhaustive tests metal spraying has been recognised by the Air Ministry as a satisfactory protective process for certain types of aero work. Spraying enables the designer to provide internal strength and other desirable features whilst retaining the external properties of some softer metal. Spraying is not confined solely to metallic surfaces, but can be applied with equal success to paper, wood, insulating materials, etc. Wooden propeller blades are sprayed with a rough surface of brass, which in turn has been sprayed with smooth outer coating aluminium. The illustrations show : (1) Standard type of metal spraying pistol ; (2) micro-photograph illustrating the compound formation produced by aluminising ; (3) the wire feed mechanism and the drive from the air-operated turbine ; (4) pressed-steel cyanide hardening pots aluminised externally to increase their life at high temperatures ; (5) aluminising aircraft exhaust extension pipes to prevent corrosion and heat oxidation ; (6) the treatment of chassis for aircraft radio equipment with zinc prevents corrosion and also seals the joints ; (3) aero exhaust manifolds being subjected to the heat treatment operation

in the aluminising process. The coating of aluminium must be at least 0.002 in. in thickness for airframe parts and 0.007 in. for exhaust extension pipes, Townend rings and cockpit heating pipes. Brief mention of the Metalock cold process, which offers distinct possibilities for engine repair work.

TECHNICAL EDUCATION.

The Cost of Apprenticeship, by W Seely. (*Mechanical Engineering, Vol. 60, No. 12, December, 1938, p. 901, 3 igs.*).

Apprenticeship involves so many intangibles that it is seldom discussed calmly and frankly in terms of cost by executives who have the power of decision. We are what we are largely because of the degree to which we have trained men through full periods of apprenticeship, whatever the literal costs in years past may have been. Basis of facts and figures necessary for valid programme. Apprentices produce enough in the shop to pay their wages. A few plants carry the apprentice-training load.

WELDING, BRAZING.

Designing for Oxy-acetylene Welding—a Survey of Fundamental Principles, by C. G. Bainbridge. Continued from January. (*The Welding Industry, February, 1939, Vol. VII, No. 1, p. 15, fig. 8*).

Designers should remember that the welder has to handle a blowpipe and a filler rod, that he excercises a considerable degree of control over the weld metal by the manipulation of both. Accessibility and freedom of manipulation are usually easiest in the case of a butt weld. Care in deciding upon the type of weld and its location with regard to accessibility, is highly important when the type of product necessitates after-treatment of the weld. Joining edges should absorb heat equally. Butt or corner joints between edges of equal thickness represent the ideal condition. The designer should understand the correct form of edge preparation to be employed. Some typical edge preparations for sheet metal are shown. For steel and certain non-ferrous metals under $^1/_{16}$ in. thick, the flanging method enables a satisfactory weld to be made without the addition of filler wire. The flanges must be exactly at right angles with the sheet surface, and the total depth of the flanged portion should not exceed twice the thickness of the sheet.

Electric Welding, by I. Ter Berg. (*The Welding Industry, February, 1939, Vol. VII, No. 1, p. 8, fig. 2, tables*).

In ordinary welding with a rod provided with an oxidising coating, it could be shown that 82% of the fused metal core is used in the weld, 12.5% is lost by spattering, and about 4.5% is lost due to oxidation by the coating, while evaporation plays only a minor part (.1%). If instead of the ordinary atmosphere, nitrogen or compressed air is used as gas environment, little change is observed; more or less iron is then also oxidised by the flux. When a mixture of hydrogen and nitrogen is used, this reaction does not take place at all. Care must be taken not only to have a low loss from spattering, but also that the coating of the rod should possess little or no oxidising power, or that the coating should give off gases during welding which form a reducing atmosphere around the arc.

Reconditioning Diesel Engines, by J. K. Johannesen. (*The Welding Industry, Vol. VI, No. 6, July, 1938, p. 188, 5 figs.*).

The repair of Diesel cylinder castings has assumed great importance, and considerable research has been carried by welding engineers on the question of reconditioning various parts depreciated in service. Take first the cylinder head. The service conditions are severe, and special arrangements are therefore

necessary. A sixteen-burner muffle furnace was designed for special conditions of heat turbulence, and built to accommodate these heads, the feed nozzles projecting through ports in a steel floor upon which a firebrick wall is erected to enclose the casting. It is, of course an advantage to use pyrometric control of the pre-heating, in which case a total temperature of 850°C. should be allowed. Standard silicon cast-iron rod is used together with the usual flux, and after welding is complete the casting should be reheated to a dark cherry for annealing, and every precaution taken so that it cools slowly and evenly. Successful repairs have been made to numerous heads. The waterjacket of the cylinder proper where the faces which hold the sleeve in position often corrode badly was reconditioned by welding. Building up these ? in. wide faces often round the full circumference of 8 ft. 6 in. is a highly skilled job. Several complete eight-cylinder installations have been thus reconditioned throughout.

Resistance Welding Plant for Stainless Steels. (*The Welding Industry, Vol. VI, No. 6. July, 1938, p. 210, 6 figs.*).

The installation is of the Budd type, with a certain number of modifications introduced by Languepin, and depends essentially on the use of a very short welding time. The installation may be divided into three parts—the control apparatus, the transformers, and the welding tongs proper. Photo-illustrations of the elements are given.

The Simplification of Machine Production by the Use of Electric Arc Welding. by J. Thomson. (*Machinery, Vol. 53, No. 1372. January 26, 1939, p. 529. 5 figs.*).

The delivery times quoted for standard boring mills being prohibitive, a special machine was built, the construction of which was expedited by designing for fabrication by welding. One of the standard products was a tower crane used in shipyards. These cranes consist essentially of a fixed tower structure with a rotating mast and jib. The rotating portion is guided at the top by rollers which engage a vertical annular guide track some 14 ft. in diameter. This guide is incorporated in the platform structure at the top of the tower. The platform has an external diameter of nearly 20 ft., and a lathe or boring mill was required which would accommodate work up to 20 ft. in diameter. The price quoted for a vertical boring mill of 20 ft. capacity was £12,000, and the time for delivery was two and a half years. The quotation for a simpler machine which would serve for machining the guide tracks, but would be incapable of doing the general work expected of a vertical boring mill, was £2,650, and the delivery time was not less than two years. This led to the decision to design and make in the works an all-welded machine. The total cost of the machine was £1,070, a machine that will be eminently suitable for the purpose, and which was finished in nine weeks.

Welded Construction of Cast Iron for Machine Tools—II, by A. Kershaw. (*The Machinist, February 4, 1939. Vol. 82, No. 52, p. 704*).

Comparison of weight and cost, analysis of costs, average cost of welded construction.

Welded Drums. (*The Welding Industry, Vol. VI, No. 6. July, 1938, p. 205, 2 figs.*).

The Associated Offices Technical Committee, which represents British engine boiler companies, has issued a schedule of examination and tests during construction and upon completion of metallic-arc welded drums for steam generating units and steam receivers. Constructional details and preparation for welding. Heat treatment. Tests on welded seams. Non-destructive tests. Circularity. Repairs to welded seams after radiographical examination.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

BELTS AND ROPES.

The Application of Transmission Belting—II, by H. Stuart Jude. (*Power Transmission, Vol. 8, No. 86, March, 1939, p. 91 to 97, figs. 7*).

Belt failures in general result from two main causes—first, unsuitability of the type of belting for the duty, and second, the unavoidable losses of power not being taken into consideration when specifying the belt for the work. The ideal drive; the arc of contact; the area of contact; centrifugal force; the drive layout; nature of the work; small pulley diameter; correction factors; other power losses; belt slip; malalignment of pulleys.

GEARING.

Checking Spur Gear Teeth, by F. W. Shaw. (*Mechanical World, Vol. CV No. 2725, Friday, March 24, 1939, p. 289 to 291, figs. 3*).

The method here set forth obviates the uncertainties attendant upon use of the ordinary tooth vernier caliper. Measurement is unaffected by differences in the diameters of the blanks or their eccentricity, or by wear in the instrument. Evolution of formulae, example calculations, British standard corrected pinion. British standard gear. All pinions from 10 to 17 teeth have addenda greater than their working dedenda when the sum of the teeth of a mating pair is no less than 40. Gauging limitations, backlash allowances.

JIGS AND FIXTURES.

Chucks for Bar Work. (*Machine Tool Review, Vol. 27, No. 168, January and February, 1939, p. 255 to 259, figs. 14*).

Information on the design of chucks, their action and the use of spring collets and conical holders. Draw-in chucks; double toggle chucks; dead length bar chucks; collet and conical holders; spring collets; master collets and liners; conical holders.

MACHINE-COMPONENTS.

Joints for Steampipe Lines, by F. L. Cowlin, and I. P. Chittenden. (*The Mechanical World, Vol. CV, No. 2733, March 10, 1939, p. 241-243, figs. 37*).

The adoption of higher steam pressure and temperatures during recent years has drawn attention to the necessity for devising improved methods of connecting together lengths of steam piping, and for making steam tight joints for more severe conditions on a variety of pressure vessels such as valve bodies, boiler drums, etc. The Taylor ring; Chittenden ring; naval rings; Langebrugge ring; asbestos fabric ring; ring joint America; Lans ring; Will's ring; Wave ring; double cone joint; Dorey's expansion ring; Pope's patent joint for copper; the Vanstone, an American joint; the Texas and Midwest joints; Vanstone joint adapted to take an oval metallic ring;

developments of the Vanstone type ; Aiton joint ; Metropoliton-Vickers seal welded joint ; Dawson joint ; Stewarts and Lloyds long sleeve weld joint ; American examples of the simplest form of welded joint ; Sulzer joint ; upset and butt welded joint of the Ford Motor Co. ; Strap joint ; Aiton Sanbride joint, a connection for extra high pressure and temperature adopted by the American Westinghouse Co.

MACHINING METALS (COLD).

Influence de certains facteurs sur la resistance specifique a la coupe de certains metaux (*Influence of certain factors concerning the specific resistance in cutting certain metals*), par W. Biernawski. (*Machine Moderne, February, 1939, Vol. 4, No. 13, pp. 31-43, figs. 22*).

Tests with a cutting dynamometer to determine some factors concerning the specific resistance in cutting metals for a given material. The following factors are of influence : (1) Section of chip ; (2) shape of section ; (3) shape of tool ; (4) state of cutting edge ; (5) cutting angles ; (6) circonference of speed ; (7) lubricant ; (8) temperature of cutting edge. Many graphs illustrate the reciprocal influence of the different items to one another. Examples : Lathe, automatic screw machines, grinding machines. The tests have been made in the Research Department of the Technical University at Warsaw.

Some Examples of Capstan and Turret Lathe Production—VI. (*British Machine Tool Engineering, Vol. XXI, No. 115, January-February, 1939, p. 61-65, figs. 12*).

Operation plan. Tools. Working-time from floor to floor of a finished commutator ring made on a " Ward "-turret lathe.

Einspindelautomaten (*Single Spindle Automatic Screw Machines*), by H. H. Finkelnburg. (*Maschinenbau-Betrieb, Vol. 18, No. 5/6, March, 1939, p. 115, figs. 11*).

General characteristics to distinguish the very different designs. Influence of the shape of the work-piece. Number of diameters and respective speeds. Single-purpose machines. Range of speeds. Plans of different drives : one single revolution ; one left and one right-hand speed ; two left and two right-hand speeds, etc. Belt and gear drives. Interesting designs. The tool-posts : cross-slide, long-slide, turret-heads both on the cross- and the long-slide. Command by one cam and by multiple cams.

Emery Wheel Dresser. (*Machinery Lloyd, Vol. XI, No. 5, March 11, 1939, p. 29-30, figs. 4*).

Useful type of Emery wheel dresser, which may be utilised to keep grinding wheels sharp, true and balanced. The tool consists of an Emery wheel made of special grit and hardness which gives it a cutting effect almost equal to a diamond. It is securely locked on the centre hub with a nut and easily replaceable when necessary.

Milling and Profiling.—Time Data III and IV. (*The Machinist, Vol. 83, No. 5, March 11, 1939, p. 47-48*).

Scope of formula to cover both the horizontal and vertical type (profiler) of milling machines. Cleaning and oiling. Classification of part sizes. Procedure : Set-up. Table of detail operation : Set-up operations applicable to all jobs ; set-up operations applicable to set up of cutters ; set-up operations

applicable to table work; set-up operations applicable to fixture work; set-up operations to vice work. Set-up operations applicable to index head; each-piece operations applicable to all parts in vice, fixture or table.

Shearing and Notching, by C. W. Hinman. (*The Machinist, Vol. 83, No. 2, February 18, 1939, p. 17-20, figs. 5*).

Burnishing round holes. Shearing strips. Hooks remove strips. Removing piece with vacuum. Shearing and cutting off die. Shearing rectangular blocks. Portable perforating punches. Adjustable piercing die.

MACHINING-METALS (HOT).

Small Forged Fittings. Some notes on the machining of airframe components: economics in time, weight, and expense. (*Aircraft Production, Vol. 1, No. 6, April, 1939, p. 191-193, figs. 6*).

Forgings are frequently employed to-day in the construction of metal aircraft, instead of the fittings built up from sheet metal, formerly used. On the production side the use of such fittings often set problems in machining which are difficult to solve. The ingenuity of the tool designer may have to be exercised to the utmost to find a method of production which shall be at once efficient, accident-proof and reasonably cheap. Standardising methods, edge clamps; matrix castings. Weight is a point of considerable moment in drill jigs, owing to the amount of handling which they require. The design of certain forgings with machine lugs at many angles, and undercuts and lightening recesses, often involves a good deal of bench work. It is desirable to eliminate this as far as possible.

MANUFACTURING.

The Manufacture of Torpedoes. (*Machinery, Vol. 53, No. 1380, March 23, 1939, p. 777, 35 figs.*).

Specialised plant and methods at the works of the Whitehead Torpedo Co. Ltd., Weymouth. Sectional elevation and plan of a Whitehead Torpedo. The air vessel for the Weymouth 45-cm. Aero Torpedo. Details of the air vessel. The Boring Machine, showing the control cam. Special machine for shaping the internal boss. Production of After-bodies. Making the Balance Chamber Shell. The After Propeller for the 45-cm. Weymouth Torpedo.

The Whitley Bomber, by S. W. Hiscocks. Part II. (*Aircraft Production, Vol. 1, No. 6, April, 1939, p. 194-200, figs. 16*). The Sub-assembly Department: Division of the Fuselage and Wing into Sections: Special Jigs; Attachment of the Main Units.

To achieve the present high rate of production of Whitley Bombers extensive jigging is essential. In this article these jigs and the manufacturing methods associated with them are explained in detail.

MATERIALS, MATERIAL TESTING.

Der Werkstoff in der Konstruktiven Berechnung (*The Material in constructive calculation*), by A. Thum. (*Stahl and Eisen, Vol. 59, No. 9, p. 252, figs. 22*).

Development of the constructive calculation. State of stress in the loaded body. Notch-effect and stress-point. The coefficient of shape A_K. Optical investigations of stress. Fine measurements of elongation. Internal displacements in the material. Resistance by time and diagram of damage. Impact-strain. Influence of normalising. Influence of surface quality. Conditions

of melting and lasting resistance. Correct selection of material. Increase of durability by surface-hardening. Perfect design depends firstly on a far-reaching collaboration between designer and shop-expert.

Die Vorgange beim Verschleiss bei rein gleitender trockener Reibung (*The development of wear by sliding dry friction only*), by K. Dies. (*VDI-Zeitschrift, Vol. 83, No. 10, March 11, 1939, p. 307, 34 figs.*).

Many machine parts become useless by wear. For many years the resistance to wear has been improved, and new specially resistant materials have been developed. Trials were made with dry sliding friction using a hardened disc of chrome-steel on very soft steel (0.04% C.). The results are reported. Arrangement of the test-stand. Influence of total way and load. Appearance of the worn surfaces. X-ray photos of the new and the worn material graphs of temperature and friction. Composition of the wear dust. Influence of the surroundings. Friction coefficients in different gas-atmospheres. Structure of the worn upper zones. The result depends on the specific load, temperature and the surrounding means.

Modern Aluminium Alloys. A survey of the materials to various specifications available for use, by I. R. Handforth (*Aircraft Engineering, Vol. XI, No. 121, March 1939, p. 101-106 11 figs.*).

The most striking feature of the new factories is the size and the cost of the equipment now used to produce wrought light alloy products. The interior of a modern flying boat, showing details of the structure and the internal arrangements for the crew. Six tables contain : (1) Sheet and strip alloys-single figures on chemical compositions show maximum permitted ; (2) casting alloys (not heat-treated) ; (3) casting alloys-precipitation hardened at 150 to 175° C. ; (4) casting alloys-solution treated ; (5) casting alloys-solution treated and artificially aged ; (6) wrought alloys.

The Mechanical Characteristic of Rubber, by F. L. Haushalter. (*Transactions of the A.S.M.E., Vol. 61, No. 2, February, 1939, p. 149-160, 22 figs.*).

The author presents some of the characteristics of rubber in which engineers may be interested from a design standpoint, without going into detail on every phase of the subject which might affect design. He points out that there is a vast amount of data still to be collected, especially to establish accuracy on some points that seem to be in doubt. He suggests to obtain data accurately, it will be necessary to conduct tests in rooms where humidity and temperature are closely controlled. The author presents data showing that moduli of elasticity and the creep of shear and torsion springs are decidedly affected by temperature. Presented graphically are curves showing load-deflection, shear, and torsion characteristics of various rubber specimens including compression pads, rubber shear sandwiches, and torsion springs.

MEASURING METHODS.

Checking the Alignment of Kendall & Gent Plano-Milling Machines. (*Machinery, Vol. 53, No. 1377, March 2, 1939, p. 681, 10 figs.*).

Brief report on the alignment of these machines during erection. Great importance attaches to this operation, since, when in service, modern requirements are such that the machines are expected to work to very close limits. Lining-up the uprights. Fitting the Cross-rail and Cross-slide. Regarding the milling heads, particular care is taken to ensure the true running of the cutter spindles prior to mounting them in the heads. After completion of the assembly of the machine, the various alignments are checked again and they must conform to the limits specified on the assembly test sheet reproduced. An interesting point relating to the plano-milling machines to which reference may be made is the means used for synchronizing the dual elevating motion for the cross-slide on the uprights.

The Use of the Spectroscope in the Inspection of Ferrous Materials, by A. Fisher. (*Machinery, Vol. 53, No. 1379, March 16, 1939, p. 745, 20 figs.*).

When it is stated that the whole spectroscopic examination of a piece of steel for the closely approximate quantitative, as well as the exceedingly accurate and reliable qualitative determination of manganese, chromium, tungsten, molybdenum, cobalt, copper, titanium and other elements can be carried out in less than ten minutes time by a youth of average intelligence after tuition and practice for two weeks, the value of the spectroscopic method will be immediately realised. The method cannot be used for the determination of non-metallic constituents. For the rapid sorting of steels, however, in mixed or incorrectly marked batches, or the rapid checking of the alloy content in incoming materials, the method has no equal. Non-ferrous materials can be examined in exactly the same manner (with the exception of aluminium alloys), checking or sorting of brasses or bronzes being a matter of minutes only, with certain accuracy. The amount of material used during the examination is negligible, being generally of the order of a fraction of a gram. The principle of the Spectroscope. Diagrammatic Plan view showing the arrangement of the Spectroscope. The use of the Spectroscope. The Spectroscopic analysis of steel. Comparison maps of : (1) pure iron ; (2) chromium ; (3) vanadium ; (4) manganese ; (5) copper ; (6) cobalt ; (7) molybdenum ; (8) tungsten ; (9) nickel.

Light Ray Control for Machine Tools. (*Machinery, Vol. 53, No. 1378, March 9, 1939, p. 713, 8 figs.*).

An outstanding feature of the two-spindle drilling and reaming machine is the application of photo-electric cells to the control of the intermittent traverse movements of the spindle heads on the vertical columns. The cycle of operations of each head is controlled by two photo-electric cells, the light passing to these cells through slots in revolving discs. The slots permit the passage of light rays at certain pre-determined points of the cycle, which bring about the various head movements, such as slow feed into the work, fast reversal to clear the drill of swarf, fast return back to the cutting position, and so on. After the drill has broken through one of the journals, it automatically traverses fast to the next position, and the cycle is repeated until all the main journals are drilled. The principal advantage attaching to the photo-electric cell control is that for changing over from one job to another all that it is necessary to do is to substitute different discs, appropriately slotted. General arrangement of the machine. The feed drive with two motors. Step-drilling machine with photo-electric control shown in side and front elevation. The sequence of operations. Sectional views of the feed-drive mechanism. The movements of the drill-head are controlled automatically by the mechanism shown in a detailed illustration. Since the adoption of the drilling reaming machine, the average drilling and reaming time per crankshaft has been reduced to 40% of that formerly taken.

Some Notes on Serration Gauges and the Gauging of Splined Components, by G. A. Tomlinson. (*Machinery, Vol. 53, No. 1378, March 9, 1939, p. 721, 4 figs.*).

It is essential, for various reasons, that splined couplings should be a good fit, and the manufacturing tolerance on the work is commonly restricted for this reason to an amount of the order 0.001—0.0015 in. The work itself must therefore be made almost with gauge precision, and the controlling gauges can of necessity be allowed only extremely narrow tolerances. Hence it is usual to find a tolerance of only about 0.0001 in. allowed on the pitch (or flank) diameter of a spline gauge. The pitch diameter is virtually increased by errors in all other elements, such as spacing, axial alignments, and angle of

the serrations. Errors in these elements may readily increase the effective value of the pitch diameter by several times the amount of the tolerance on diameter, and it is clear, therefore, that the exact effects of such errors should be realised and also that limits should be imposed accordingly on the extent of these errors. Diagram showing effect of flank angle errors on the pitch diameter of a serration gauge. Diagram showing why a correction for eccentricity should be made in assessing the spacing errors of a serration gauge. Diagram showing the effect of spacing errors on the virtual pitch diameter of a serration gauge. Diagram showing how the work tolerance may be curtailed as a result of errors in the serration gauges. The total effect on the virtual gauges. The total effect on the virtual diameter of the spline gauge with quite small assumed errors in other elements is shown in the table below.

Element	Error	Virtual increase of pitch diam. inch
Angle of flank	α = 1 min.	
	β = 2 min.	0.0001
Spacing of teeth	$\pm$ = 0.0001 in.	0.00039
Alignment of teeth	0.0001 in.	0.00019
	Total	0.00068

The gauging of splined components is beset with considerable difficulties. The effective size of a gauge will differ from its measured size in most cases by an amount which is quite large compared with the diametral tolerance allowed. This discrepancy should be kept within bounds by allotting tolerances, which must of necessity be fine, to all the elements of the gauge.

X-rays and Their Applications to Industrial Problems, by F. W. Spiers. (*Machinery, Vol. 53, No. 1380, March 23, 1939, p. 797, 7 figs.*).

A description, in simple terms, of the method of producing X-rays, and their use in the non-destructive examination of materials. Production of X-rays. A diagrammatic illustration of a modern X-ray Tube in its simplest form. Properties of X-rays. Their penetrating power in light substances is high, and heavy materials are required to absorb them completely. Photographic recording is possible because X-rays very readily blacken a photographic plate or film.

Tube voltage, kilovolts	Thickness in inches for 1% Penetration		
	Steel inch	Aluminium inch	Wood inch
50	1/32	1/2	5
100	3/16	2 1/2	9
200	1	4	12
400	2	6	14

Diagnosis of internal faults. Method of projecting an X-ray shadow of an object to a sensitive film. The depth of a flaw in an object can be estimated by taking two radiographs with the tube focus in different positions. Industrial applications of X-rays. Radiograph of a welded seam. Extensive crack

in a pressure vessel revealed by a radiograph. A portable industrial X-ray-outfit. Philips Industrial X-ray Service. X-rays are also proving very effective aid industrially in connection with the study of the internal structure of crystalline material.

PLASTIC MATERIAL

The use of Plastics in Aircraft. An examination of the materials available, with results of tests on their suitability. by E. P. King *Aircraft Engineering* (*March, 1939, Vol. 11, No. 121, pp. 96-100, 15 figs.*).

Brief survey of the basic resins, their properties and development. Among the natural resins shellac stands out both in its origins and properties. The other natural resins, or gums are mostly of vegetable origin. Rosin, dammar mastic, copal, cauri, and asphaltic compounds are all soluable and thermoplastic. Brief mention of the properties and possibilities of the four chief thermoplastic materials-cellulose, acetate, styrene, acrylic, and vinyl polymerization products. Cellulose acetate may be obtained in sheets, rods, tubes, etc for windscreens, window panels, control wheels with metal centres, etc. Data on toughness, nailing, moulding, bending. Cellulose acetate does not burn easily, discolour or become embrittled except after very long exposure to air and sunlight. The affinity of cellulose for water is perhaps its chief disadvantage, and gradually it is being replaced for windscreens, etc. by the newer acrylic resin materials, such as " Perspex," " Plexiglas," etc. A comparatively new and most interesting class of resin are the Vinyl polymerization products. As " Gelvar." " Butvar," " Alvar," or " Formvar," polyvinyl acetate may be used for impregnating fabrics and veneers prior to pressing.

Thermo-setting resinous materials, which are of major importance in the development of plastics for stressed parts and primary structure of aircraft.

Formaldehyde, bakelite. Table gives the strength/weight ratio of a number of different types of material. Graphs show variation of moisture absorption, tensile and compressive strength of " improved " birch wood as a function of density. Results of comparative tests on plain spruce and Bakelite reinforced joints.

The Elastic and Plastic Properties of Rennet Casein, by C. A. Cooper. (*British Plastics, March, 1939, Vol. 10, No. 118, pp. 572 to 577, 8 figs.*).

A method is described of comparing the elastic and plastic properties of rennet caseins by compression of standard moulded pieces between heated platens. Data for sixty samples of casein of various countries have been included, and it has been found that there is no definite connection between the deformation of these caseins under heat and pressure and other properties, such as fat content, ash, pH, etc. The effect of varying temperature pressure and moisture content of casein of this deformation is also described. It is suggested that this method should prove of value to manufacturers of casein helping to produce a standard quality most suitable to the needs of manufacturers of casein plastics. The objects of this work was to measure the deformation of casein, before and after hardening in formaldehyde, when subjected to the combined action of heat and pressure. One casein may be eminently satisfactory in processing, while another from the same source behaves in a very different manner. Casein Standard. Method of determining deformation by Scott figures. Temporary deformation; permanent deformation; recovery; variation of deformation with (1) moisture content; (2) temperature; (3) pressure; (4) country of origin. Scott figures and other properties of casein.

For supplying data as to wether a given sample of casein is suited to the manufacturer of a plastic material, plasometer measurements of deformation

and physical properties. Information as to the compressibility of casein under conditions of the Scott test should prove of great help to producers of casein in various parts of the world in attaining greater uniformity in the physical properties of casein.

POWER DRIVE

Elektrische Drehzahlregelung an Drehbanken (*Electrical speed control of lathes*), by K. Maekcer. (*Werkstattstechnik, 15 February, 1939, Vol. 33, No. 4 pp. 97-105, figs. 13*).

There are three tasks in designing a headstock : (1) Fine stepped regulation or an infinitely variable drive with great range ; (2) adjustment of any speed from the carriage ; (3) pre-selection of the next number of speed ; and engaging automatically the selected speed prepared by hand. Investigation of the electrical solution is better than that one by hydraulical or mechanical means. The article deals only with lathes up to 20 h.p. motor.

Regulation in steps by alternative current motors : (1) the motor with changing poles ; (2) the double cage motors and the motor with quick frequency.

Infinitely variable regulation (a) with alternate current, (b) with direct current. Slip ring motor, alternating-current commutator motor. Shunt-motor by using resistances in the armature circuit or by weakening the field.

Conclusion : The best solution for the lathe is the alternative triphase motor with changing poles, then the direct current shunt motor and for bigger drives the Leonard shunt motor.

PSYCHOLOGICAL INVESTIGATION

The Worker's Attitude to his Job, by T. W. P. Vasey. (*Industrial Welfare and Personal Management*), *March, 1939, Vol. 21, No. 243, pp. 89 to 93*).

They are not merely " things " going in at 8-0 a.m. just to push this, pull that, but are all the time thinking, hoping, planning, and what is more important from the employer's point of view, grousing. Although it is true to say that the job itself can have some effect on the worker's attitude toward it, it is equally true to say that factors not intimately connected with the job can exert a much stronger influence. Amongst the many internal factors are : (1) type of foreman ; (2) type of labour ; (3) outlook and policy of the management ; (4) opportunities for promotion ; (5) hours of labour ; (6) recreational facilities ; (7) security of employment. Investigation carried out by Messrs. Wyatt & Langdon of the Industrial Health Research Board. Wyatt & Langdon in their investigation took three factories in different parts of the country, staffed almost entirely by female labour on repetitive work. A list of 10 important factors was drawn up : (1) security of employment ; (2) comfortable working conditions ; (3) pleasant working companions ; (4) good supervision ; (5) opportunities for promotion ; (6) high wages ; (7) opportunities to use own ideas ; (8) the type of job which makes one think ; (9) shorter hours ; (10) the type of job which requires no thought.

The factors governing the worker's attitude to his job are not merely those operating within the factory and thus to some extent capable of being controlled by the management and formen, but a great many of them are *external*. Note an investigation carried out by the Western Electrical Co., Chicago and quoted by Professor Elton Mayo in his book, " The Human Problems of an Industrial Civilisation." To conclude, it may not be inappropriate to quote from the opening abstract address by Professor John Hilton, at the Industrial Welfares Society's Conference at Oxford, in 1936.

RESEARCH

The Fretting Corrosion of Closely Fitting Surfaces, by G. A. Tomlinson, P. L. Thorpe, and H. I. Gough. *The Engineer, March, 10, 1939, Vol. 147, No. 4339, pp. 324-326, figs. 5*). Same article in (*Engineering, March 10, 1939, (Vol. 147, No. 3817, pp. 293-295, figs. 5*).

The mutual corrosion at the contact surfaces of closely fitting machine components, when subject to vibration must be distinguished at the outset from the ordinary wear by the fact that it alwys occurs at contact surfaces which are for all practical purposes fixed in relation to each other. Example : a ball race housing with a press fit on the shaft. Other examples from practice include spline fits, shafts, and hubs of keyed gears, engine bearings, collects, etc. Vibration appears to be an essential factor in the process. Fretting corrosion is of special interest in the aircraft and automobile industries. The class of work under consideration is produced with extremely close manufacturing tolerances. The investigation was carried out at the National Physical Laboratory on behalf of the Aeronautic Research Committee. Two almost independant sections were used (1) flat surfaces in contact to which known stresses—normal and tangential—were applied ; (2) an experimental method was devised, using the more geometrically ideal contact of a sphere and a plane Experimental apparatus. Haigh alternating stress machine. The specimens are in the form of three annular rings threaded on a common shaft, pressed together in the axial direction by a known force up to 3,000 lb. The two pairs of surfaces in contact are subjected to a normal steady load and to a vibratory tangential torque, each of known magnitude and independently variable. *Apparatus for slip measurements.* When a minute amount of slip is permitted, rapid corrosion of the surfaces always results, whether they are clean or oiled The measured relative movement of the specimens with increasing alternating tangential stress is shown in a graph. *Experimental results.* Without exception in all the experiments with no slip the surfaces are practically unchanged, and when slip occures the surfaces are always corroded. The presence of oil does not in any case prevent corrosion though it generally modifies the effect. In general the softer materials show more tendency to seize and less tendency to produce " corrosion debris " than the hard steel. *Experiments with a spherical and a plane surface.* In this apparatus a sphere 2¼ in. in diameter is held between two horizontal flat plates one beneath it and one above it, the upper plate being loaded as required by means of a weight and lever. Photographs of the indentation area with hardened steel surfaces under a load slip is the criterion for the occurence of corrosion, and moreover, the abrupt change shows the criterion to be extremely critical.

The effect of the intensity of normal pressure. For these experiments flat surfaces were used and a test specimen was made of hardened and tempered steel. The apparatus was used indentically as in the experiments with the sphere and plane. The amount of corrosion is not greatly influenced by the intensity of pressure. *Additional experiments .* A series of tests have been carried out in which only the nature of the material has been varied. Hardened steel, mild steel, a well-known stainless steel, brass, nickel, chromium, " Y " alloy, and glass. The tests have been made with dry clean surfaces. There was not a single instance of no corrosion. *The effect of lubricants.* The presence of the lubricant has in general the effect of reducing the rate of corrosion. The primary cause of fretting corrosion is of a mechanical rather than chemical nature. There are some good reasons for regarding the corrosion to be due to attrition of the surfaces on a molecular scale. The experimental data is too meagre for a theory to be pursued beyond this without indulging in speculation. If the theoretical conclusions are valid, corrosion must be placed in the class of molecular phenomena and as such may have to be regarded as being inevitable like cohesion or friction.

SHOPS AND SHOP MANAGEMENT

A Case History in Salary and Wage Administration, by Samuel L. H. Burk, (*Personnel, February, 1939, Vol. 15, No. 3, pp. 93-129, figs. 9*).

Much has been written on the principles of wage and salary administration, but inadequate treatment has been given to their practical application and to the pitfalls and obstacles encountered in a job evaluation programme. In one of the most comprehensive case studies on the subject that has appeared the author describes the rate-setting procedure of The Atlantic Refining Co. and discusses those difficult phases of a salary and wage administration programme at which theories must be reconciled with practical considerations. Preparing the hourly-rated descriptions. Developing a measuring-stick and grading. Pricing the difficulty and importance scale. Administration. The salaried position study.

SMALL TOOLS

Precision Tapping at High Speed. *Lloyd Machinery, February 25, 1939 Vol. 40, No. 4, pp. 19-24, figs, 9*).

Rigidity, dynamic balance and precision methods of manufacture are fundamentally just as important in the conception of a tapping machine as in any other machine which operates a cutting tool. A high speed tap is capable of cutting at the same speed as any other high-speed metal cutting tool. The Haskins Methods of High Speed Tapping. The tap head is a self-contained united fitting into the motor housing and containing the mechanism for driving and reversing the spindle shaft. Provision is made for multiple speeds of the tap spindle to ensure efficient cutting for the entire range of taps for each machine.

TECHNICAL EDUCATION

Le Probleme de l'Usinage dans les Ecoles Techniques (*The Machining Problem in the Technical Colleges*), by M. R. Prudhomme. *Mécanique, Vol. 23, No. 282, January-February, 1939, p. 32, figs. 13*).

All agree on the important factor which the art of machining represents theoretically and practically. The organsiation of the lectures must comprise the full conception of tools and machine tools. Further important matters are : the standardisation and the methods of mass-production and the rational exploitation of the machines. The three fundamentals are : preparation of the work, its execution, and control. Special tools and their design, as examples. Nothing ought to be left to the hazard, each problem needs : good working conditions, strict analysis, and careful synthesis on the basis of practical experience in design and machining.

General Discussion on " Electrical Engineering Education " Introductory Remarks by C. L. Fortescue. (*The Journal of The Institution of Electrical Engineers, February, 1939, Volume 84, No. 506, pp. 161-168, no figures*).

Scope of the remarks ; the objectives of the training, the general lines of the required training ; the university plus postgraduate apprenticeship versus works and technical institutions ; the theoretical training ; the practical training ; research.

WELDING, BRAZING

Assembly Plant for the Mass Production of Welded Barges and other Structures—Part I, by G. F. Wolfe. *The Welder, January, 1939, Vol. 11 (new series), No. 62, pp. 2-8, figs. 10*).

The rapidly increasing demand for all welded equipment combined with the seasonal delays precipitated a study of production methods which led to

the adoption of an assembling line method and a completely housed operation. A two-bay building of all-welded construction was erected, the building consisting of one main bay of 91 ft. 6 in. span for erection of vessels and a side bay of 63 ft. span for receiving and storage of materials and for preliminary assembly operations.

Plan view and elevation of the assembly building in respect of the launching ways. A construction view of the two-bay building before the side walls were added. A special fitting table was developed to automatically space and hold the separated angle sections during the assembly and tacking operation. The tacked assembly is taken from the jig to tilting tables. The supporting structure for blocking the barge during assembly in position consists of permanent steel supports at the propper level for convenient access for welding beneath the barge. Lap joints are used and the entire assembly is turned over in order to secure downhand welding throughout. The power for the moving of the assembled barges is furnished by two single drum electric hoist engines acting through a wire rope system.

Kraftbetaetigte Spannfutter an Drehbaenken (*Power-operated Chucks of Lathes*), by K. Devring, (*Maschinenbau/Betrich, Vol. 18, No. 56, March, 1939, p. 125, figs. 15*).

Pneumatically, hydraulically, electrically operated chucks. The superiority of compressed air : clean, simple, flexible, best adaptable : diameter, weight, moment of inertia of the cylinder. The tandem cylinder, the power-muliplier ; other important details, examples.

Pruefung von Metallen und Hartmetallen mittles Hartmetallscheibe (*Testing of metals and hardened metals by the cemented tungsten carbide disc*), by N. Sawin. (*Werkstattstechnik, March 15, Vol. 33, No. 6, pp. 165-170, figs. 21*).

The qualities of different materials regarding wear are proved by rotating dises of cemented carbide. These tests give valuable information for the practical usefulness of materials. It is of special importance for the tool maker to get reliable results of the raw materials of the tools (high speed steel, cemented carbides). It is the task of the future to get data for their conduct when actually cutting. The wear testing machine of Skoda-Sawin. Testing Johansson blocks with the Rockwell-C-test, data sheet of tests with nine cemented carbide tips (different makers).

Histoire du Nickel (*History of Nickel*) **Le nickel dans l'Industrie,** by Joseph Dhavernas edited by *Centre d'Information de Nickel-Paris. (1938—Part I and II p. 70, figs. 40*\.

Very interesting review of the development of the Nickel industry in Europe. Geography, geology, metallurgy in almost all countries of Europe, Canada, U.S.A. Illustrations of the most important plants. Graphs showing the world's production from 1885-1937 beginning with 600 tons year ending with 100,000 tons year.

The use of Nickel in industry and its most important alloys. The use of Nickel for railways, motor cars, aviation, mining, shipping, machine-tools, tools, rolling-mills, electrical, chemical industry, architecture, and coining. Nickel and corrosion.

Einteilung der Endmasse, Verwendung ihrer Ordungsgruppen und Genauigkeitsgrade und Ersatz (*Classification of reference blocks, utilisation of their order groups, their degrees of accuracy and repair*). by R. P. Schröder. (*Werkstattstechnik, March 15, 1939, Vol. 33, No. 6, pp. 173-175*).

The ISA-Committee distinguishes (1) Original measuring gauges ; (2) comparison ; (3) checking ; (4) working gauges. These four groups form a complete set. The article examines in which cases all groups are necessary or in which 2 or 3 are sufficient.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, CASEHARDENING, TEMPERING.

The Hardening of Machine Tool Beds by the Shorter Process. (*Engineering, March 31, 1939, Vol. CXLVII, No. 3820, p. 382, figs. 2*).

The Shorter process in essential, is a mechanically controlled method of hardening by quenching, the wearing surfaces of machine parts, in which the heating is effected by means of specially designed traversing oxy-acetylene, or similar fuel burners and the quenching by means of a jet of water, or in some cases air, following immediately. The Shorter process has been applied to the surface hardening of shafts, journals, axles, brake drums, wagon wheels, and tyres, and numerous other machine parts, as well as gears, and a somewhat new application which is of interest is shown, namely the hardening of lathe and other machine-tool beds. The body of the blowpipe is fitted to a mounting unit, which enables the heating burner and the quenching jet to be controlled and also adjusted vertically, according to the height of the lathe bed.

BELLS AND ROPES.

The Application of Transmission Belting—III, *by H. Stuart Jude.* (*Power Transmission, April 15, 1939, Vol. 8, No. 87, p. 153 to 158, figs. 15*).

The Drive Layout. Horizontal drives, vertical drives, drives at an angle, crossed drives, quarter-turn drives, cone drum drives, stepped cone drives.

KINEMATICS.

Cam Design, by W. Richards (*Machinery, April 6, 1939, Vol. 54, No. 1382, p. 9, figs. 2*).

Methods and processes described allow an analysis, in which instantaneous values of the velocity and acceleration of the follower will be obtained. Displacement graph for a cam. It has been shown that velocity values are obtainable from a displacement curve, and in a similar manner acceleration values may be obtained from a velocity curve. Graph used in the derivation of cam slopes.

ELECTRICAL ENGINEERING.

E.M.I. Cathode-Ray Television Transmission Tubes, by I. D. McGee and H. G. Lubszynski. (*Journal of the Institution of Electrical Engineers, April 39, Vol. 84, No. 508, p. 468 to 482, figs. 8*).

A short history is given of the development of two types of cathode-ray tube now used for transmission of television pictures. The construction and mechanism of operation of the " Emitron " is described and its limitations

are discussed. A further development namely the " Super-Emitron," is then described, and its mechanism of operation and its performance are compared with those of the " Emitron." Some other types of transmitting tubes, which have been tested experimentally in the course of this work are described briefly.

HEATING VENTILATION

The By-Passing of Boilers to obtain Varying Working Temperatures, by Joseph Riemer. (*The Heating and Ventilating Engineer, April, 1939, Vol. XII, No. 142, p. 464 to 466, figs. 2*).

It is often desirable with hot water heating installations to have different temperatures in different parts of the piping, especially in spring and autumn. With large plants some sections may have different heat demands as a result of their exposure. Installations having circuits with radiant heaters are likely to have cooler water in the radiant heaters than in normal radiators or convectors. All these demands could most suitably be met by supplying the trunk mains of the different circuits with water of different temperatures. This can be easily carried out by applying one or more by-passes allowing the water to shunt the boiler. Two solutions are illustrated.

FOUNDRY.

The Renfrew Foundries of Messrs. Babcock & Wilcox, Ltd. (*Engineering, March 31, 1939, Vol. CXLVII, No. 3820, p. 359 to 362, figs. 6*).

Detailed plans of the different departments, views, electric arc furnaces The output of the plant amounts to 60 tons of reconditioned sand per double shift.

Rollcurve Gears, by H. E. Golber. (*Transactions of the A.S.M.E. for April 1939, Vol. 61, No. 3, p. 223 to 231, figs. 11*).

By using rollcurve gears, the follower can be given practically any desired motion, thereby enabling the designer to produce the follower motion desired and obtain the best condition in the new machine. The article first illustrates actual rollcurve gears installed and in use on actual machines. It discusses their durability and applicability, and gives a short history of some of them.

The article shows next the production of the " speed graph," which is a standard method developed by the author to make the desired method perfectly definite. It is then shown how to convert the speed-graph into rollcurves which may be drawn and tested on the drawing board. The rollcurves can then be used to obtain patterns for the gear blanks. These gear blanks have the teeth cut into them converting them into a pair of gears. When the driver moves at uniform speed, the follower moves in the desired motion. The result is positive and reliable.

Certain features that occur in connection with the rollcurve gears are explained. Also, to show the broad applicability of the gears, a few speed-graphs, for which gears have already been made, are commented upon.

GEARING.

Checking Spur Gear Teeth, by Francis W. Shaw (*Mechanical World, April 7, 1939, Vol. CV, No. 2727, p. 349 to 350, figs. 4*).

II.—The Pin or Roller System. Reviewing the system in general of gauging by pins located in opposite tooth spaces, the author recommends the use of

pins of the same diameter for all standard gears of the same pitch, and shows how the pin diameter and caliper settings are calculated.

Comparison of methods three variations of the system of checking gears by pins located in the tooth spaces. The minimum pin diameter. The illustration of the formula for the minimum pin diameter. Derivation of formulae for caliper measurement : A for even tooth numbers ; B for odd tooth numbers ; C for the " straddle " method (odd tooth numbers only). The caliper setting. Specimen set of calculations.

Profiles of Cutters or Abbrasive Wheels for Producing Involute Helicoidal Gear Teeth, by W. A. Tuplin. (*Engineering, March 17, 1939, Vol. CXLVII, No. 3818, p. 297 to 299, figs. 4*).

The tooth forming operation, cutting, or grinding, is carried out on a machine in which the cutter or abrasive wheel rotates about a fixed axis while the gear-blank is moved in a direction parallel to its own axis and simultaneously receives a proportional rotation about that axis. The relation between translation and rotation of the gear blank is arranged so that the motion relative to the blank of any fixed point is a helix of the required lead.

For any particular gear, the profile of the cutter or abrasive wheel depends on the angular position of its axis relatively to that of the gear.

A practical example is calculated.

LIGHTING

Industriebeleuchtung mit Metalldampflicht (*Industrial lighting with metal vapour lights*), by Udo Hartlieb (*Siemens Zeitschrift, Vol. 19, No.3, p. 123, figs. 4*).

The technique of lighting has recently undergone changes as to light-sources of special capacities such as those of the modern metal-vapour lamps ; the mercury-vapour lamp, the natrium-vapour lamp, and the mercury-vapour compound light. The metal-vapour lamps show, by comparison to incandescent lamps of equal capacity an increase of lighting hours of two to four times. By the sameness of the colour of its light as well with the mercury-vapour as the natrium-vapour lamp the sharpness of sight increases. The colour of light nearest to daylight is when the ratio of mixture between the stream of light both of the incandescent lamp and the mercury-vapour lamp is about 1 : 1. The economy of a luminous source is given in a narrower sense by the output of light, the endurance and equipment cost. If those three factors are brought into relation to one another, it is easy to find the price of current, beginning from which the metal-vapour lighting gets cheaper than the incandescent lamp. Examples are given : A lighting of a mixture with mercury-vapour about 1 : 2, used for a hall for setting up machine tools, pure general lighting. Mercury-vapour lighting as a mixture 1 : 1, pattern maker shop, general lighting fixed always to the same place. Mixture of mercury-vapour lighting 1 : 2, for work-benches. Mercury-vapour lighting, mixture 1 : 1, spinning machine shed.

MACHINE COMPONENTS

Bearing Construction : Its Relation to Performance and Life.—I, by Albert B. Willi. (*The Machinist, March 18, 1939, Vol. 83, No. 6, p. 94E, figs. 8*)

The manner in which the babbit in the lining and the steel or bronze in the back are utilised is of great importance. The truth of this statement is evident from test observations.

A 100 hour endurance test was run on four groups of connecting rod bearings made by different manufacturers. All the bearings tested were steel back, babbit-lined, and of precision type. The composition of the babbitt in all bearings was practically identical, as was also the steel analysis. The design elements also were identical in all.

Throughout the tests extreme care was used in duplicating assembly and operating conditions to make sure that no variable factor was introduced which might affect the life of the bearings. To explain why one group of bearings can pass the test with an area of failure of only 19.4% and another group is able to withstand only sixty hours of the projected 100 hour test requires an investigation of the methods used in the manufacture of the various groups.

The methods of manufacture and their variations differ in cost and very evidently establish a corresponding range in life expectancy or mileage within certain limits. The cheapest steel-babbit-lined bearing can be roughly rated to carry a maximum unit pressure of 800 lb. to 1,000 lb. per sq. in. for a given period of time under certain operating conditions, and the most expensive bearing of the like style can be rated to carry 1,400 lb. to 1,500 lb. per sq. in. for the same length of time under the same operating conditions.

To select the most economical bearing construction requires an exact knowledge of its performance.

Waelzlager in Werkzeugmaschinen für Feinbearbeitung (*Roller bearings in machine-tools for fine finish*), by O. Schenk. (*Werkstatstechnik und Werksleiter, April 1, 1939. Vol. XXXIII, No. 7, p. 186, figs. 8*).

There are three problems :—

(1) To support the main spindle so that a cutting speed up to 3,000 ft./min. may be attained without too great a rise of temperature in the bearings, while the surface finish of the work piece is immaculate, without any vibration or chatter marks. (2) To find a bearing which ensures true running of the work piece, even after long working time. (3) To manufacture bearing, main spindle and the whole machine so that faultless surface quality is attained at all cutting speeds.

Errors of temperature with the increase of revolutions with different designs of bearings. Influence of play in bearing on the temperature of the cylindrical roller-bearing. Radial eccentricity of the rotating inner race. Examples : Main bearing of a work spindle with cylindrical roller bearings. Rapid lathe with cylindrical roller-bearings for the main spindle. Cross and axial elasticity of roller bearings. Admissible axial slip. Regarding all requirements the total out-of-truth of a main spindle running in roller-bearings, may be reduced to 0.0025 to 0.0005 mm = 0.0001 in. to 0.0002 in. measured at the free end of the mandrel, with perfect surface of the work piece. The range of revolutions could amount to 1 : 50 and more without readjusting the setting of the main bearings.

Beton-Untergestelle fuer kleine Werkzeugmaschinen (*legs, frames, uprights for small machine-tools made of concrete*), by Fr. Schwerdtfeger. (*Werkstattstechnik und Betriebsleiter, April 1, 1939, Vol. XXXIII, No. 7, p. 195, figs. 9*).

" Ersatz " must have been the guiding theme in this article. Firstly, cast iron is scarce in Germany, therefore the legs and uprights are now replaced by sheet iron boxes which are filled with concrete, or massive blocks of concrete are used, the corners of which are only protected by sheet or profiled iron. This is reminiscent of the experiments in war-time, 1917-18, when even the whole beds of the lathes were to be made of concrete. Twenty

years ago words of praise of the machine tool bed from concrete were heard, such as those of to-day regarding the legs and uprights of concrete.

LATHES

A Richards 85 ft. Diameter Vertical Boring and Turning Mill. (*British Machine Tool Engineering, March-April, 1939, Vol. XXI, No. 116, p. 105, figs. 14*).

The illustrations show general views, views of saddle and head, supplementary slide swivelled over for taper work, platform at the top, main motor gear changing motor, motor driving the lubricating pumps, control disc reversing switch, gear selector, speed grinding attachment, also for taper work.

POLISHING, LAPPING, HONING.

The Hone's Zone, by Kirke W. Connor. (*The Machinist, April 8, 1939, Vol. 83, No. 9, p. 151E, figs. 12*).

Some practical applications in gasoline and Diesel manufacture show logical uses for this method of fine finishing. Honing is fundamentallly a wet cutting process. It accomplishes four things : it removes substantial amounts of stock generates size, generates accuracy for roundness and straightness, and produces a desired degree of surface smoothness. It does not conventionally generate alignment as related to squareness, concentricity, or parallelism of axes in adjacent bores.

Depending upon the amount of stock to be removed and the final surface finish desired, the surface speeds in the honing process may range from 10 to 250 ft. per min.

The desired degree of surface smoothness is controlled by adjustment of the cutting action of the abrasive. Production requirements, of course, determine the type of honing machine and the type of fixture to be used. Illustrations indicate some of the methods used on cylinder blocks, replaceable liners, and Diesel engine bores.

Trucks and tractor cast iron or alloy sleeves are honed after a finish boring or grinding operation which has generated the necessary alignment and concentricity, but which required from 0.003 to 0.0045 in. of stock removal for clean up.

The application of honing in Diesel engine manufacture includes both smaller engine blocks as well as the larger diameter cylinder sleeves. Other large diameter applications include air compressor cylinders, railroad cross-compound cylinders, locomotive side and main rods, Diesel connecting rods, and other parts.

Boring and grinding is commonly employed as the final alignment generating process prior to honing in larger diameter sleeves. Approximately 0.005 to 0.007 in. of stock is left following the boring of larger diameter work. From 0.001 to 0.0015 in. is left for clean-up following grinding operations and approximately 0.0035 in. is left for clean-up following reaming operations.

SHEET IRON WORKING.

Simple Rules Give Better Tools, by C. Cole. (*The Machinist, April 15, Vol. 83, No. 10, p. 144 to 145, figs. 9*).

Too often overlooked, these suggested fundamentals of tool design mean much to the man who uses the tool in the shop. Small, thick parts blanket from sheet stock have a flat and a rounded side. This must be considered when designing drilling or milling jigs, and fixtures for second operations

Chip clearance is of major importance when designing jigs and fixtures. Examples are recommended. Here the surface supporting the part have been held to a minimum and there are no corners in which chips can accumulate. The use of fillister head screws for holding tool parts is to be recommended as they make it possible for the toolmaker to shift the units into proper relation with other parts before doweling. All necessary dimensions should be indicated on the tool drawing so that the toolmaker can go ahead with his work without checking over a part drawing. Clearances on locating studs are important.

MANUFACTURING.

Body Manufacture.—The Works Layout and Methods at the Pressed Steel Co. Ltd., Part II. (*The Automobile Engineer, March, 1939, Vol. XXIX, No.382, p. 76 to 80, figs. 12*).

The Morris 10 h.p. all-steel body assembly has been selected as a typical example of efficient assembly layout, of which a plan is shown. During the assembly cycle an underframe is placed on the main conveyor, and the side panels, roof, and trunk are assembled. Reference is made to the various methods by which the various components flow to their respective positions. The meeting point is shown, also the floor track and two assembly jigs. Owing to the shape of the building the finishing point for the side panels is some distance from the point of assembly of the panels to the body conveyor.

Final body assembly is carried out on a continuous floor-type conveyor designed with a large number of trucks spaced at intervals and travelling at a regulated speed. After spraying, the body is reversed to its normal position, lifted by electric hoist, and transferred by overhead tracks to the paint priming line. Inspection and final touching up follow, after which the body is lifted from the conveyor by an electric hoist, and lowered on to the platform truck in readiness for removal to the shipping platform.

A new building is designed with three entirely self-contained departments for the manufacture of wings, composite parts and aircraft components. Each section contains the requisite presses and plant so that all operations can be carried out without assistance from any other department. Adjacent to the presses are large storage racks to hold the work in readiness for final operations.

Prior to shipping the wings are automatically oiled in the booth.

In the chassis frame department the chassis frames are previously formed to shape on large presses and painted.

Machining Steel Bottles for Torpedoes (*Machinery, April 6, 1939, Vol. 54, No. 1382, p. 1, figs. 14*).

Interesting methods and special equipment at the works of the Whitehead Torpedo Co. Ltd. The engine oil bottle at various stages during the sequence of manufacturing operations. Methods of holding the half-bottle for the first operation. Sectional view showing the work done at the second setting. Special equipment for holding the half-bottle when finishing the exterior. Method employed for locating the half-bottle when finishing the interior.

Quantity Production of the Spitfire I.—Notes on the system adopted by Vickers-Armstrongs, Ltd. (*Aircraft Engineering, April, 1939, Vol. XI, No. 122, p. 167 to 180, figs. 45*).

The main planes. A few interesting details of the main-spar structure. The trunnion-mounted main-spar drilling jig, with the root-end drilling fixture

in the background. The jig for lining up the nose ribs to individual templates and a centre-string before skinning. Drilling the main-spar from a movable drill mounted on the jig. Typical nose ribs in their assembly jigs. The set-up used for drilling and reaming the roots of the spar booms of the starboard plane. Three representative photographs of jigs used in the checking, trimming, and drilling of the upper and lower skins of the leading edges. A leading edge on the erecting table with the top skin already assembled. Some typical rib details. A general view of the first type of main-plane assembly jig with the leading edges uppermost. The massive welded tubular master jig for checking the accuracy of the main-plane erection jigs. Port and starboard root-end main-plane ribs in their assembly jigs. Part of the lower surface of the starboard main-plane, showing typical details of the construction. The way in which the strength of the top skin is maintained in the radiator and undercarriage openings is of particular interest. The interchangeability gauge used for checking the hinge alignment and clearance of the aileron. Some details of the main fuselage structure. The tubular and girder engine mounting, which is assembled by bolts and rivets. A typical fuselage frame jig. The three-part fuselage : engine mounting, main fuselage, and tail section. The assembly jig for the fireproof bulkhead and mainspar bridge. The fuselage erection jig. The spar-root bolt-hole reaming operation. Part of a line of rear fuselage assembly jigs. The interior of a rear fuselage, showing the structure and the attachment of the Vickers oleo-piston. Drilling jigs for a rear fuselage panel and a section of the leading edge skin of the fin. Master gauge for the rear fuselage jig. A jig used for assembling one of the rudder ribs, these are made from duralumin tubes riveted together with wrapping plates. The type of jig used on the assembly of the ailerons. The main flap in its interchangeability gauge. Two of the drilling jigs used in the construction of the elevator spar. The jig used for shaping and assembling the skin of the ducted radiator.

Untersuchung ueber das Bohrenvon Kunststoffen (*Investigation, on drilling of synthetic material*), by E. Sachsenberg and H. Klein. (*Maschinenbau-Betrieb, Vol. 18, No. 718, April, 1939, p. 177, figs. 19*).

Correct grinding of twist drills for synthetic resins. Angles of centre-lips, of flute-inclination, relief. Clogging of cutting edges and flutes. Surface finish. Thrust. Torque. Temperature. Short time-testing method.

MATERIALS, MATERIAL TESTING.

Magnesium Alloys for Industry, by A. Kufferath. (*Aircraft Engineering, April, 1939, Vol. XI, No. 122, p. 149 to 150, figs. 3*).

The production and treatment of the lightest known metallic constructional materials. Their low specific weight of 1.8 makes these magnesium alloys the lightest metallic constructional materials in existence and their various working treatments, including casting, pressing, rolling, and machining (permitting exceptionally high cutting speeds), are considerably cheaper than those of the heavy metals.

Two methods of manufacturing pure magnesium, thermic reduction of magnesium ores, and the electrolysis of magnesium salts, are still being used. Pure magnesium is used for a few isolated and comparatively unimportant purposes. By far the largest quantities are employed in the form of alloys developing surprisingly fine technical properties, which in conjuction with their low weight, render them eminently useful for aeronautical purposes. The only really satisfactory method of developing protective surface layers on magnesium alloys has proved to be the " Elomag " method.

Magnesium alloys are usually supplied in the form of suitably shaped ingots for all types of casting methods as well as in finished and semi-finished forms such as rods, pipes, or tubes, sections, wire, and strips. A number of magnesium alloys are supplied in the form of forged parts used as machining alloys and for etching purposes. Some forged magnesium parts are shown as examples. Practically no finishing treatment is required for die cast materials.

Machining of magnesium alloys generally corresponds with that of aluminium alloys, the only difference being slight modifications of the cutting tools. The cutting speeds are very high. Machine tools have been developed which raise the cutting speeds beyond anything possible with any other alloys, reaching 2,000 to 6,000 r.p.m. in special lathes and revolvers, and from 10,000 to 20,000 r.p.m. in drilling and boring machines of special construction, depending on size.

Turning, drilling and milling are best carried out without any lubricant or fluid coolant whatever.

Burning magnesium alloy chips or turnings can easily be extinguished by covering with cast-iron chips or shavings. Water should under no conditions be poured on these chips as this may cause the formation of explosively extending flames.

The method of joining magnesium alloys most frequently and successfully employed in welding : Four different types of welding can be employed for this purpose : (a) Fusion welding with acetylene or hydrogen ; (b) electric resistance welding for wrought alloys ; (c) the so-called " pouring" welding of castings ; (d) pressure welding for certain isolated purposes.

Soldering with special solders containing cadmium should be applied only for certain special purposes. Attention is expressly called to the fact that these soldered sections are not resistant to high mechanical or thermic stresses.

The specific weight of the magnesium alloys ranges from 1.76 to 1.81. Magnesium alloys are particulary suited for the photographic and optical instruments use in aeroplanes, such as cameras, telescopes, etc., but these alloys can also be used to advantage for engine and gear cases, lubricating oil pumps, oil pumps, and lines, fuel-oil lubricating filters, starting and braking wheels, cowlings and fairings, ventilator-blades, brake cheeks, compass casings, automatic controls, gyroscopes, airscrews blades, etc.

Neoprene Cork Gaskets (*Neoprene News, 1939, No. 3*).

Neoprene Gaskets for automobile engines used to be made of cork granules bonded with a glue-glycerine composition, and garages and service stations found them very awkward to store. If the atmosphere chanced to be damp they would weaken, grow mouldy, and finally disintegrate. On the other hand, storage in a dry atmosphere caused them to shrink, so that they would no longer fit the engine for which they were made. At the same time they became so brittle that any attempt to stretch them during fitting led to immediate breakage.

The success of neoprene composition products was remarkable. They remained unchanged in size and strength under all ordinary conditions of storage, did not break when the engine was dismantled, and by reason of their durability and elasticity, could be used several times, always giving a perfectly tight seal.

Neoprene Air Hose in Glass Works (*Neoprene News, 1939, No. 3, p. 11*).

Flexible hose plays an important part in glass moulding. Through it is supplied the compressed air required to operate the machines. A certain manufacturer of glass fruit jars employed a special type of rubber hose in his machines, but after a period he found that its inner surface broke up, allowing pieces of rubber to be carried into the mechanism. It was then necessary to shut down and replace the hose. The disintegration of the inner tube of the

hose, accompanied by a swelling of the cover, was not only due to the heat (averaging about 200°F.) but also to the fact that the machines were lubricated through the air hose.

The manufacturer tested a hose in which both the cover and the lining were of neophrene. This was examined after eighteen months' continuous service and still showed no evidence of deterioration.

Nickel, Cast Iron for Heat.—Resisting Applications in Engine and Boiler House Equipment. (*The Nickel Bulletin, March, 1939, Vol. 12, No. 3, p. 53 to 56, figs. 5*).

Cast iron has been used since the earliest days of engineering practice for castings subjected to heat.

At elevated temperatures cast iron components may fail due to loss of strength. More frequently, however, failure results from structural changes in the metal which lead to growth and decay, followed by distortion and perhaps ultimate fracture.

The development of alloy cast irons and particularly of those containing nickel, has given continuous and reliable service under the severest conditions.

The article deals with: the failure of cast iron under heat, the development of heat-resisting cast iron, heat resistance with machinability, heat resistance with toughness, the high alloy heat-resisting cast irons.

Testing Hardness of Very Thin Metals. (*Mechanical World, April 21, 1939, Vol. CV, No. 2729, p. 390 to 391, figs. 1*).

For the first time an instrument of the ball impression type has appeared for measuring the hardness of very thin metals. Foils are being increasingly used in manufacturing processes and the ascertainment of hardness is an important factor in their working. General view of the new Salford tester for measuring the hardness of very thin metal sheet and foil. Material of the order of two or three hundredths of a millimetre can be dealt with.

MEASURING METHODS, APPARATUS.

Wirtschaftliches Pruefen in der Reihen-und Massenfertigung. (*Economical checking in batch and mass manufacturing*), by E. Wittwer. (*Werkstattstechnik und Werksleiter, April 15, 1939, Vol. XXXIII, No. 8, p. 209, figs. 24*).

Checking as a separate operation of manufacturing. Checking is also carried out in piece-work.

I.—Choice and order of the checking instruments. *A*, bring pieces to be checked in the measuring position. There are three cases possible : 1, gauge and work piece are moved ; 2, gauge is fixed, piece to be checked is moved ; 3, gauge is moved, piece to be checked remains in its place. *B*, determine the result : 1, by sight ; 2, by touch.

II—Influence of shape of gauges on checking time.

III—Special tool for checking mass quantities.

IV—Checking while manufacturing.

V—Means to decrease the time of checking : *a*, subdivision in simplest checking operations ; *b*, automatic measuring instruments.

Methode de mesure des efforts de coupe des outils (*Methods of measuring cutting forces*), by M. Mauzin. (*La Machine Moderne, XXXIIIe Annee, No. 368, March, 1939, p. 125, figs. 10*).

The measurement of cutting forces is the leading feature to study in the function of machine tools. It is the best and only reliable basis from which to

calculate the supporting elements and groups of components correctly. The apparatus used here is based on the principle of the piezo-electric quartz. The illustrations show : the mounting of the quartz crystals in the cell ; a scheme for verifying the absence of influence between quartz and cathodic oscillograph; designs to register the cutting forces of a lathe, a shaper, a drilling or a milling machine ; executed instrument on a radial drill ; graphs taken on a lathe and a radial drill. (It may be mentioned that the use of a piezo-quartz for this purpose is not new. Piezo-instruments constructed for the same purpose were designed and published by Okochi and Okoshi, the Japanese scientists, in 1929).

Manufacturing Tolerances, by H. Parkinson. (*Aircraft Engineering, April, 1939, Vol. XI, No. 122, p. 165 to 166, figs. 2*).

In fixing a scale of limits for aircraft manufacture the tolerances must be based on the production of small quantities with due regard for interchangeability and the use of a minimum of jigs and tools. Such limits should be as coarse as can conveniently be allowed. Limits are given for : standard bolts and pins, drilled holes, woodscrew holes, reamed holes, rivet holes, drilled holes in wood, shafts, special bolts and pins, profile dimensions, castings and forgings, bolt and rivet holes, centres, and locating dimensions, angles, fork end fittings, control surfaces, levers, etc.

Messung Kurzzeitiger Drehzahlschwankungen. (*measuring short-time variations of revolutions*), by F. Eckel. (*Zeitschr, VDI Vol. 83, No. 13, April 1, 1939, p. 381, figs. 6*).

For accurate tests on regulators and determining the degree of unconformity of combustion engines, a new instrument was developed, by which very short-time variations of speed can be drawn without inertia. A disc with a series of holes is used as sender, and a photocell in the measuring circuit. Frequency up to 3,000 Hertz ; time recorder marking 1/25 sec.

X-rays and the Internal Structure of Metals, by F. W. Spiers. (*Machinery, April 13, 1939, Vol. 54, No. 1383, p. 41, figs. 5*).

The term " crystalline material " includes, in addition to commonly known crystals and metals, a variety of substances such as cellulose, wool, hair, rubber, glass, clays, and similar materials. Any substance having some regularity of chemical structure can be examined by X-ray analysis with good prospects of obtaining knowledge of its internal arrangements. The internal arrangement of a simple crystal is represented diagrammatically. The manner is shown in which photographs can be taken to measure the angles of X-ray reflections and given information about the spacing of the layers of atoms in a crystal. Metals, however, are poli-crystalline, i.e., composed of a large assembly of minute crystallites. For such substances the method described is still applicable, but in a modified and somewhat simplified form.

Some of the uses to which such photographs can be put are illustrated. The photographs have been reproduced by permission of Dr. G. W. Brindley, of the Physical Department of the University of Leeds ; they were taken in the course of various investigations on the reflection of X-rays by metals and alloys.

METALLURGY OF STEEL.

Beitrag zum Duplexverfahren : Thomasbirne—Lichtbogenofen (*Contribution to the Duplex-method : Thomas converter—Luminous arc furnace*), by R. Graef. (*Stahl & Eisen, Vol. 59, No. 13, March 30, 1939, p. 385, figs. 13*).

Short history of development. Metallurgical investigations. Process of dephosphorisation, desulphurisation, desoxydation. Proportion of nitrogen in duplex steel. Examples of melting. Causes of electrode-consumption. Influence of voltage. Non-combustible shutting of big arc-furnaces.

PLASTIC MATERIAL

Injection Moulding of Thermo-Setting Plastics, by Alfonso Amigo, Part II. (*British Plastics and Moulded Products Trader, April, 1939, Vol. 10, No. 119, p. 628 to 634, figs. 11*).

The various kinds of injection moulding of thermo-setting artificial resins : (A) Filling chambers for multiple charges (*a*) with cold mould and subsequent hardening, (*b*) with warm mould and subsequent pressing, (*c*) with hot mould. (B) Filling chambers for single charge : (*a*) filling chamber in the mould, (i) individual moulds, (ii) multiple moulds ; (b) separate filling chambers, (i) individual moulds, (ii) multiple moulds ; (1) without automatic locking, (2) with automatic locking ; (c) several filling chambers.

Systematic illustrations with good explanations of all different kinds.

POWER DRIVE

Commande individuelle et modernisation des machines-outils. (*Individual Drive and Modernisation of Machine Tools*). by L. Lenouvel. (*La Machine Moderne, XXXIIIe Annee, No. 369, April, 1939, p. 208, figs. 8*).

The old transmission line is disappearing more and more. Even if the " cosinus " is decreasing, the advantages of individual drive for production out-weigh the loss in power. For modernising old machine tools and providing standard modern tools with individual drive there exist many solutions, a good selection of which is shown : Cotal gear box for modernisation of old machines, with four speeds and electric brake ; (a) mounted on the floor, (b) mounted on the bed of the machine tool. (1) Driving and driven parallel axles are on the same side. (2) Driving and driven axles are on opposite sides. Another Ernault-Cotal gear-box of eight speeds forward and eight speeds backward, or 16 speeds forward. Application to new machines. Conclusions : (1) The adaptability of a machine is improved ; (2) the amount of time lost is reduced.

Elektrische Antriebe von Drehbaenken (*Electric Drive of lathes*), by Weigel. (*Maschinenbau-Betrieb, Vol. 18, No. 718, April, 1939, p. 167, figs. 9*).

Development of the individual electric drive of lathes by Siemens Schuekert Works, Berlin. Use of the triphase alternate current motor in its simplest and safest form as short-circuit motor for small and middle-size machine tools. The direct current is preferred only for big lathes on account of its easy regulation. Two view points : (1) Constant power ; (2) constant turning moment. Regulation of numbers of revolutions. Leonard-drive. Mixed regulation. Electric braking to dead stop. Electric change of direction. Frequency of interruptions. Ventilation.

PSYCHOLOGICAL INVESTIGATION.

Industrial Psychology in Italy, by C. A. Ferrari. (*Occupational Psychology, April, 1939, Vol. XIII, No. 2, p. 141 to 151*).

Professor C. A. Ferrari of the University of Rome describes developments in industrial psychology in Italy during the past few years. In Milan selection tests have been devised for use in Italian cotton mills and for selecting women on sorting and carding wools. Italian research on conveyor bands has also confirmed the need for machines which can be adjusted to several different speeds so that the individual needs of workers can be met as far as possible. Extensive work has been carried out in Rome and Florence while in Turin

there is a laboratory devoted mainly to the interests of workers, special attention being paid to training and assisting those handicapped by ill-health or injury.

Occupational Success, by M. B. Scott. (*Occupational Psychology, April, 1939, Vol. XIII, No. 2, p. 126 to 140*).

Some of the difficulties are discussed with which the vocational psychologist is faced in trying to make an accurate estimate of the occupational success both of those to whom advice has been given and of those constituting " control " groups for the purpose of comparison. The investigations described were concerned with two groups of very different constitution. The first group consisted of 1,200 boys and girls (approximately 600 of each) who at the age of fourteen left certain elementary schools in one district of London during a period of eighteen months. The N.I.I.P., with the co-operation of the Care Committee, head teachers, and the Juvenile Labour Exchange, kept in touch with all the 1,200 children to ascertain their occupational progress. Inquiries were made at somewhat irregular intervals for a period of four years.

The second group consisted of 1,310 boys, girls, and adults who voluntarily sought the help of the Institute in choosing their careers during a period of six years. The majority were between the ages of sixteen and nineteen. An inquiry into their occupational progress was made from three to five years after they had sought the advice of the Institute, and in the case of 240 a second inquiry was made from eight to ten years after the consultation.

The bearing of the two groups on the method of inquiry. Output as a criterion. Average number of posts and length of tenure. Reason for leaving posts. Employers' reports. Satisfaction of the worker. Lack of a unit. Extra-occupational desires. Compensation. The adoption of false goals. There are great difficulties in the way of estimating occupational achievements when both efficiency and some degree of satisfaction are rightly considered of importance.

In general, from the investigator's point of view the detailed study of individual cases is not only the easiest but also the most reliable method of determining how accurately prediction can be made.

The Mental Manifestations of Some Industrial Illnesses, by Howard E. Collier. (*Occupational Psychology, April, 1939, Vol. XIII, No. 2, p. 89 to 97*).

Dr. Collier of Birmingham University maintains that industrial illnesses are frequently due to a variety of causes some of which may be physical and others psychological in character. It is therefore essential that both the physical and the psychological aspects of industrial disease should be given adequate consideration in diagnosis and treatment. Examples : the effects of industrial solvents, the effects of carbon monoxide and the cyanides, the effects of mercury, the effect of manganese, the group of so-called " nervous " disorders.

SHOP AND SHOP MANAGEMENT.

Works Management of a Small Factory or Works. Points from a Paper by Mr. P. G. Robertson before the Institution of Production Engineers. (*Industrial Power and Fuel Economist, Vol. XV, No. 162, March, 1939, p. 82 to 86*).

We can broadly divide our analysis into five parts : (1) Design, (2) labour, (3) materials, (4) work costs, (5) general considerations.

(1) The drawing office ; its function staff and power to help. Importance of the schedule. In its reputation for thoroughness it should be the one document whose accuracy cannot be challenged.

(2) Labour factors ; combining estimating, planning and ratefixing in one staff.

(3) Materials ; delivery is entirely the buyer's responsibility, materials are money.

(4) Works costing ; simple ways of collecting the right figures. Definitely no time sheets, job cards or any other sheets should be written out by the operators themselves. The practice of letting them do so is far more common than one would suppose.

(5) General points ; dirty shop—the safety factor—the team spirit.

Responsibility of the Works Manager for Safety, by R. J. Woods (*Industrial Power, Vol. XV, No. 163, April, 1939, p. 114*).

The first problem of the management is to decide who is responsible for safety. With the exception of compliance with instructions and the exercise of ordinary personal care by individual workmen, responsibility for safety should rest entirely with the management. Some firms spend large sums of money on guards, protective clothing and devices, and incidental to the safety campaign, a tremendous amount of time is devoted to safety meetings and discussions ; and by their acts of carelessness or negligence workmen fail to respond to the management's efforts. The reason for the workmen's apathy should be ascertained and suitable steps should be taken to counteract it. Workmen will sometimes confess to having been careless. This usually means that they are unable to assign a reason for their act or omission. Some particular factors which are the primary causes of accidents are seldom considered. Fear of heights and an impulse to put the hand into moving machinery are examples. Accidents may be classified broadly as follows : A, those resulting from movement of personnel or objects or a combination of both, and B, those resulting from chemical action. The problem of accident prevention is now, in progressive firms in which safety has received systematic attention for years almost entirely a psychological one and more account should be taken of this in safety campaigns. Accidents should primarily be considered with respect to their fundamental causes. Normal investigations into accidents should be confined to ascertaining adequate safeguards against a repetition. Personal safety devices should be considered as temporary measures. Effort should always be made to minimise danger at the source.

Canteen Accounts, by A Surman. (*Industrial Welfare and Personnel Management*), *April. 1939, Vol. XXI, No. 244, p. 144 to 147*).

The information that employers will naturally require concerning their canteen may be outlined as follows :—

(1) How much is the canteen costing to run ?

(2) What does a meal cost to produce ?

(3) What percentage must be added to the cost of a meal to (a) make the canteen self-supporting ? (b) cover such overheads as the employer has decided it shall carry ?

(4) Are all the stores and provisions purchased by the canteen properly accounted for ?

(5) Is all the cash taken in the canteen properly checked and accounted for ?

Handling of accounts. The chief records : (1) stores records, (2) purchase journal and ledger, (3) cash system and sales records, all of which are co-ordinated by summarised totals in (4) nominal or private ledger. Profit and loss account with an example.

SMALL TOOLS

Gestalt und Anwendung der Fraeser (*Shape and use of milling cutters*)—Information by A.D.B. Committee—Hegner. (*Maschinenbau—Betrieb, Vol. 18, No. 718, April, 1939, p. 175, figs. 1 and table*).

Dependence on material to be machined. Three groups: I.—Standard construction steels—1 DIN 1661 St. 42.11, St. 50.11, St. 60.11, St. 80.11. 2. DIN 1661—St. C.16.61, St. C.45.61.

II.—Tough-hard steels (cementable or normalised): ECN (1662), ECMo (1663). VCN. (1662), VCMo (1663), high speed steels. Carbon-toolsteel, stainless and steel castings. (St. 52.81—1681).

III.—Light metals.

Data of diameters, bores, inclination of flute, number of teeth. Illustrated tables with proposals for all different shapes.

The Mounting of Diamonds for Turning and Boring Tools, by P. Grodzinski. (*Engineering, April 7, 1939, Vol. CXLVII, No. 3821, p. 418, figs. 10*).

The securing of the diamond by means of a clamping plate will be greatly facilitated if the diamond is lapped on two sides to give parallel faces. The arrangements are illustrated. A development is shown. In this case the diamond is lapped to a wedge shape, both top and bottom, and on the sides. The angle in the vertical plane is 90° while the blanks are sloped to an included angle of 30°.

The ideal type of support for a diamond in a turning or boring tool is probably some form of ball seating. This distributes the cutting stress over a relatively large area, and gives an automatic adjustment for any small inaccuracies in manufacture. An arrangement which has proved quite successful is illustrated. A considerably more compact tool may be produced by forming the diamond with a spherical lower surface, so that it forms its own ball support. An arrangement of this kind is shown in section. The resetting of the diamond required skill and judgment. As it is undesirable that the resetting of the diamond in any of these tools should be attempted by an unskilled operator, it is the practice, in some cases, to provide a seal for the clamping screw.

Diamond Tools. Modern Application in the Manufacture of Engine Components, by P. Grodzinski. (*The Automobile Engineer, March, 1939, Vol. XXIX, No. 382, p. 95 to 97, figs, 8*).

It is the chief object of these tools to produce a highly polished extremely accurate and smooth surface so that parts can be assembled without any further machining or finishing operations. The speed is increased to as high a figure as is practicable to obtain the highest possible finish with vibrationless running, but on the other hand, the feeds and cutting depths are reduced to a minimum. A diamond is capable of finishing an extremely large number of components without requiring adjustment or re-lapping. It is necessary, of course, to discriminate regarding the material to be finished. Cemented carbide-tipped tools, in addition to their use as roughing tools, are suitable for finishing steel and cast-iron, whereas hitherto the field of application of the diamond has been restricted to the finishing of non-ferrous alloys, bearing metals, light alloys, precious metals, and non-metallic synthetic materials. Already, however, diamond tools are being employed with satisfactory results for finishing small cast-iron refrigerator and compressor cylinders. Diamond tools have been generally adopted for finishing pistons, usually with four different operations: the skirt, the crown, the ring grooves, and the gudgeon pin holes. Tolerances on this work in the case of a piston 2.65 in. diameter by 2½in skirt length are 0.0005 in. for size and shape, the actual ovality being 0.012 in.

For finishing gudgeon pin holes, duplex fine boring machines are now commonly employed*. The use of diamond tools for boring a number of bearings in line effects a great saving of time, besides eliminating much highly skilled work. Running-in times can be greatly reduced or entirely eliminated, and at the same time finer bearing clearances can be adopted owing to the lower initial wear. Progressive manufacturers are now using diamond tools both for boring and facing the bearing seats in light alloy crank-cases. A diamond tool opens the structure of lead bronze and similar alloys and produces a perfect surface which required no additional finishing.

A relative new process is the milling of cylinder block and crank case surfaces, using cutters provided with inserted diamond tools. Usually four or six tools are employed and produce very smooth and flat surfaces, but it is of course necessary to adjust the tools independently and exactly to the same cutting radius.

*—With this equipment the production time is fifty seconds per piston to a tolerance of 0.0001 in.

SURFACE TREATMENT.

How to Metal Spray, by I. G. MacGrath. (*Aluminium and the Non-Ferrous Review, March, 1939, Vol. 4, No. 4, p. 138 to 140, figs. 22*).

Ordinarily a light weight portable metal spray gun which may be fixed in position as required, is employed. Four supplies are necessary : metal wire, oxygen, acetylene, and compressed air. Sprayed metal is built up in structure by the interlocking and partial fusion of minute molten metal particles projected from the spray gun.

Flat surfaces are blasted with angular steel grit, sharp Cape May sand, or Joplin grit, as sharp edges must be employed. When surfaces have been prepared for metal spraying they must be kept clean from grease or dirt.

In sand or grit blasting all parts that are not to be metal sprayed are shielded.

Subjects exposed to the elements are never sprayed during bad weather. During wet weather it is impossible to metal spray. In spraying for corrosion resistance, the most important part of the process is the bond. Extreme care is exercised in preparing the surfaces of vessels, tanks, pipes, and surfaces. As a rule the natural finish of metal spraying applied over a blast-cleaned surface is satisfactory for corrosion resistance application.

Where small parts such as bolts, nuts, brackets, scrap iron, angle irons, pipe fittings, handles, pins, etc., can be handled in production, these are metal sprayed efficiently and economically in a mass coating machine. This machine is very like the ordinary tumbling barrel used in metal cleaning and plating.

Whenever iron or steel is exposed to high temperatures, hot flue gases or flame, deterioration of the metal is rapid or the deposition of soot and clinkers seriously reduces combustion efficiency. To a great extent we correct the condition by " alumetising." Merely spraying with aluminium does not alumetise an object. Other operations are necessary including the most important of all-heat treating. The rules are given.

Protection of Base Metals by the Use of Metallic Coatings, by C. E. Heussn. (*Aluminium and the Non-Ferrous Review, March, 1939, Vol. 4, No. 4, p. 135 to 137, figs. 2*).

Cementation coatings, metallic coatings applied by the cementation process includes " sheradising " in the case of zinc and " calorising " when aluminium forms the coating.

In sherardising, the parts to be treated are cleaned and sand-blasted or pickled then packed in drums containing finely powdered zinc. The drums are slowly rotated for several hours in a furnace at a temperature of 50 to 750°F.

In the " calorising " process aluminium is applied to other metals in a manner similar to that of " sherardising." The metal parts are packed in steel drums containing a mixture of aluminium and aluminium oxide. The drum is rotated in a furnace for about five hours at a temperature of about 1740°F.

Sprayed coatings. Any of the common metals can be sprayed by the use of the modern metal-spraying equipment. The list includes aluminium, copper, iron, steel, lead, nickel, tin, zinc, and such alloys as babitt, brass, bronze, Monel, and stainless steel. The most recent type of gun (Schoop) includes a rapidly revolving air turbine which pulls the wire from the spool and, by means of knurled rolls, feeds it through the gas mixing chamber and out the nozzle. With the gases ignited at the nozzle the wire is melted in the flame cone. The bond of the base metal is strictly a mechanical one and is said to vary from 250 lb. per sq. in. for copper on steel to 850 lb. per sq. in. for tin on steel.

Electroplated coatings may be used for corrosion resistance and also for decorative appearance. Coatings used for dual purposes in this way are all in the group cathodic to steel. Deposits of this type, such as nickel coatings on steel require coatings of at least 0.0005 to 0.001 in. in thickness. One of the most common coatings used for this purpose is chromium. The chromium is deposited directly on steel to depth of 0.003 in. or more, depending on the wear and corrosion resistance desired. For most of the common coatings there are several different types of baths and different operation conditions that produce satisfactory results. A few of the more typical bath compositions and the operating conditions of the baths are given : Zinc plating, tinplating. copper plating.

WELDING, BRAZING.

Welding of Copper, by C. H. S. Tupholme. (*Sheet Metal Industries, April, 1939, vol. 13, No. 144, p. 538 to 540*).

Several peculiarities of copper make the welding practice very different from those employed for steel of the same thickness. Copper has a high thermal conductivity. In the molten form it readily absorbs much gas. This gas is released as the metal cools and if it has not been entirely eliminated from the weld metal before it reaches the pasty condition it remains in the form of blowholes, making the weld metal porous and very weak. This metal is also very weak when hot ; at 900°F copper sheet has less than one-half the tensile strength it has at atmospheric temperature.

While copper resists atmospheric oxidisation to a marked degree it will take up much oxygen when in the molten state. In the refineries most of the oxygen is removed during the process of " poling " the molten copper in the large reverberatory furnaces.

The difficulty encountered in securing a strong bond with electrolytic copper points to the use of an oxygen-free material. This can readily be obtained by remelting the electrolytic copper and adding a deoxidiser in amounts sufficient to react with all of the oxygen.

A somewhat special technique has been developed for autogeneous copper welding (i.e., using a copper filler rod) and training and experience are necessary if the process is to be carried out to the best advantage.

It is very important that the natural flame be employed exclusively. In handling the blowpipe, it should be borne in mind that the metal should be kept thoroughly melted at all times during welding. Welding in a vertical position on material over $\frac{1}{8}$ in. thick is extremely difficult to perform if a neat appearance is essential and a true weld is required, owing to the fluidity of molten copper. It should only be undertaken by skilled operators when absolutely unavoidable.

In some instances both the oxy-acetylene and electric arc welding process are more conveniently effected with copper alloy filler rods of lower melting point than the copper to be joined, and the process is then known as " bronze welding."

Bronze welding is especially applicable when welding in awkward positions, as in pipe joints and overhead structure, for there is then more certainty of securing a sound joint.

Designing for Oxy-Acetylene Welding, by C. G. Bainbridge. (continued from February, 1939, *The Welding Industry, April, 1939, Vol. VII, No. 3, p. 102 to 106, figs. 9*).

Copper and aluminium, and most non-ferrous metals, can be welded underhand without bevelling the welding edges up to about $\frac{1}{8}$ in. thick ; over that thickness each edge should be prepared to a 45° bevel, thus providing a contained vee angle of 90°.

Instructive illustrations show : angle between fusion faces, allowance for weld metal contraction, the design of pressure vessels, tanks, and other containers, connections, stiffeners.

Hartloeten in Durchlaufoefen (*Hard brasing in continuously running furnaces*), Report. (*Maschinenbau-Betrieb, Vol. 18, No. 718, April, 1939, p. 181, figs. 22*).

Hard brazing with protective gases. Procedure, preparation of work pieces auxiliary means, brazing metals, flux, treatment of the finished connection.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ACCOUNTING, ADMINISTRATION.

A Maintenance Budget? Why Not? by D. Black. (*Factory Management and Maintenance, Vol. 9F, No. 4, April, 1939, p. 61, figs. 6*).

The system of the Detroit Lubricator Company. The total maintenance expense is about 5.5% of total overhead costs. With 70 people in the maintenance department the total expense is large and must be carefully controlled. Control is by a budget. The expenses are divided into two groups: general and special. General maintenance represents items such as cleaning windows and floors and oiling machinery. Special maintenance consists in the irregular items, such as repairs to floors and machinery. Work orders, time tickets, requisition sheet for maintenance material. Work cards kept by plant engineer to accumulate data. General budget-sheets of each department go monthly to plant engineer. Labour analysis weekly posted by accountant from time tickets and material requisitions. The accounting department issues the indirect labour analysis showing the amount spent for these same items of expense. This budget plan has been in satisfactory operation for ten years; its management enables decisions to be made on the proper allowance for maintenance.

BELTS AND ROPES.

The Application of Transmission Belting—IV, by St. Jude. (*Power Transmission, Vol. 8, No. 88, 15 May, 1939, p. 223, figs. 8*).

Lenix drives; mule drives; reverse drives; serpentine drives; the rules for correct application; rule 1—find the ratio drive; rule 2—fix the pulley diameters; rule 3—find the belt speed; rule 4—find the maximum horsepower. Correction factors for various types of load.

COOLANT, LUBRICANT.

The Effect of Size and Shape of Cut Upon the Performance of Cutting Fluids when Turning S.A.E. 3140 Steel, by O. W. Boston, W. W. Gilbert, and L. V. Colwell. (*Transactions of the A.S.M.E., Vol. 61, No. 4, May, 1939, p. 315, figs. 20*).

Results of detailed experiments to determine the influence of each of several classes of cutting fluids on tool life when turning steel with different size of cut. The tests were divided into three series: First, two cuts were used having the same area, in one case the depth was equal to eight times the feed, and in the other the depth was equal to twice the feed. In the second series of tests the feed was kept constant while the depth was varied over a considerable range to give cuts of different area. Lastly, all data are correlated to show the influence of each type of cutting fluid as a function of the size and shape of cut, as a function of the cutting speed for a given tool life, and in terms of the volume of metal removed per tool grind.

Wear in Lubrication Problems, by L. M. Tichvinsky. (*Transactions of the A.S.M.E., Vol. 61, No. 4, May, 1939, p. 335, figs. 29*).

Boundary or semifluid friction takes place in bearings of practically all rotating machines when they are started or brought to a standstill. This type of friction, lasting a short period of time, is usually accompanied by the wearing of the bearing surface, the journal surface, or both. Wear takes place also in the case of antifriction bearings due to sliding, rolling, or combined sliding and rolling friction. Many other causes, such as misalignment, dirt, or inadequate lubrication, might be responsible for wearing of any type of bearing. This paper deals with the methods which are employed to obtain the wear resistance of various metals, especially those used in the design of bearings.

EMPLOYEES, WORKMEN.

Factors in Industrial Health, by I. R. Rees. (*Industrial Welfare, May, 1939 p. 171*).

Known sickness figures; sickness absence. The commonest causes of absenteeism are still the catarrhal infections, colds, and so-called influenza; these provide about 29% of the total; accidents provide about 11%, and then there follow gastric disorders, rheumatism and nervous conditions. By far the most common cause of prolonged incapacity (i.e., periods over twenty-nine days) is *neurosis*. It is a fact that approximately one-third of all the serious ill-health of this country is due to psychological or emotional disorder and not to organic structural conditions. Anxiety, hysteria, and obsession, less well-defined neuroses; self-observation; environmental factors; application in industry; prevention of neuroses. Vocational selection will help, tackling the difficulties of individuals in an early stage before they have become too involved and too chronic.

FOUNDRY, MOULDING.

Economic Foundry Production, by the late E. Ronceray. (*Engineering, Vol. CXLVII, No. 3824, April 28, 1939, p. 511, figs. 4*).

History: The first attempts at mechanisation date from 1875-80; the Familistère de Guise concern constructed a very important machine, shown in the plan. This machine included four stations, three of which had turntables, servings uccessivelyf or moulding, patching-up and closing, pouring, and knocking out. A hydraulic moulding press rammed up large moulds; the sand was concentrated at one spot, transported, moistened, milled, then riddled on the boxes. In 1893 what is thought to be the first American installation made its appearance at the works of the Westinghouse Air Brake Company, of Wilmerding, Pa. Principle of reduction of handling. Three cardinal conditions are to be taken in consideration: (1) To reduce the number and importance of the handlings; (2) to reduce their cost to the minimum; and (3) to design and build the plant so as to avoid frequent stoppages and reduce upkeep charges. Pouring and metal analysis. The first requisite for mechanisation is a sufficient daily tonnage of metal of a given composition, and the next, that this metal can be poured either continuously or at very short intervals. They require the use of conveyors and of the cupola. The duplex process: the cupola and the electric furnace. Brass and aluminium foundries; steel foundries using converters for the " baby " Bessemer converter. Casting arrangements for steel foundries. Steel may be produced by the crucible, open-hearth, electric, or converter processes. The high-frequency furnace has not yet reached a stage at which production in quantity is possible. Non-ferrous and light alloys; sand preparation; sand handling; sand elevators; principal storage hopper; mould conveyors; coring-up, and closing of the moulds.

Die Casting Practice in the United States. (*Engineering, Vol. CXLVII, No. 3825, May 5, 1939, p. 527, figs. 2*).

Messrs. Mt. Vernon Die Casting Corporation of New York City is producing both zinc-alloy and aluminium die-castings, with occasional brass-alloy castings. Each die-casting machine has its own individual furnace, but the alloys are prepared in a small room adjacent to the die-casting floor. The "Zamak" alloys contain zinc of a high degree of purity. The No. 3 alloy of this series, which is used exclusively at Mt. Vernon, for instance, contains 3.9 to 4.3% of aluminium, 0.03% of copper, and 0.03 to 0.06% of magnesium. The remainder consists of zinc which is over 99.99% pure. Plunger die-casting machine for zinc alloys; die plate of zinc-alloy machine with four dies. Reference is made to the effect of the molten metal on the dies. This is known as thermal fatigue or "heat checking," and is a form of surface failure. Heat checking depends more on temperature than on use: the dies for zinc alloy castings, for instance, will last almost indefinitely without showing it; those for aluminium alloy, which has a higher casting temperature than zinc alloy, will suffer in time; while those for brass alloys, having a still higher melting point, heat-check rapidly and require relatively frequent re-dressing. About 80% of the dies are of the unit type, but if a casting is required which is too large for a standard die, the frame can be removed from the machine and a single large die used, as in the more conventional die-casting machine.

KINEMATICS

Fabrication d'une Came Cylindrique Destinée a établir un Contact suivant une Fonction Variable du Temps (*Making a cylindrical cam to follow a movement of variable time-elements*), by I. Sapy. (*La Machine Moderne, Vol. XXXIII, No. 371, May, 1939, p. 393, figs. 6*).

A circuit of fluid must be closed during the varying fraction of a given time and opened during the rest of the time of the cycle. The calculation, the graph and the executed design of the cam are shown.

MACHINE COMPONENTS.

The Economical Form for Roll Neck. Bearings of Synthetic Resin Plastics, by I. Arens (*Mechanical World, Vol. CV, No. 2730, April 28, 1939, p. 415, figs. 4*).

Conventional form of bronze bearings for large hot rolling-stands (barrel diameter over 500 mm.). The bearing surface should be just long enough to allow a carrying film of lubricant to form, that is to say, not longer than $L = 0.6 - 0.8\ D$ (D = diameter of neck). It is better to have the specific surface pressure somewhat higher, or, if necessary, to increase the diameter of the neck than it is to have the bearing surface longer than O.8 D. Block bearing of synthetic resin plastic. Conditions for thickness of radial shell. Bearing of synthetic resin plastic with crescent-shaped cross-section: utilised cross section of bearing, remaining cross section of crescent-shaped bearing, saving in material.

GRINDING.

Faulty Grinding and Its Correction, by H. J. Wills. (*The Machinist, Vol. 83, Reference Book Sheet, May 13, 1939, p. 225*).

Given a definite grinding problem involving materials and machines of known characteristics, a wheel manufacturer can furnish a wheel accurately fitted for the job. The variable unknowns are: the condition of the grinding machine, skill of the operator in manipulating the wheel, and even to the operator's psychological reaction. It is the unknown quantities which require expensive experimentation. Detailed tabulations of grinding faults show how

a grinding problem can be solved without recourse to specially made wheels. Tables contain : I.—Chatter, defect, cause, methods of correction. II.—Scratching of work. III.—Wheel grading effect. IV.—Wheel loading. V.—Wheel glazing.

MILLING.

The Production of Metal Patterns. (*Machine Tool Review*), Alfred Herbert, Ltd., (*Vol. 27, No. 169, March-April, 1939, p. 284, figs. 6*).

A Keller three-spindle automatic toolroom machine for machining metal patterns, core boxes and driers. The adoption of automatic methods in foundries and the tightening up of tolerances on castings so that they will fit the jigs used in the machine shop has necessitated the production of more accurate patterns. It is often necessary to make the patterns of harder materials than the ordinary pattern metal. In addition to patterns, core boxes have to be made more accurately, and as the number of core boxes required is generally a multiple of the number of patterns, exact duplication is most desirable. The well-known Keller automatic toolroom machine developed as a three-spindle machine is ideal for metal pattern work. Examples : Two clutch housing patterns being machined from a wooden master. Two metal patterns for an exhaust manifold for an internal combustion engine. Machining a manifold core box. Metal radiator pattern.

Whenever more than one of a kind of pattern or core box is required, or the moulding and casting is done on a production basis it has been found that machined patterns are in the long run cheapest to produce and most satisfactory to use.

Berechnung der Schnittleistung bei Fraesarbeiten. (*Calculation of cutting-output of milling operations*), by Hegner, Chairman of Committee for Milling of ADB-Berlin. (*Maschinenbau, Vol. 18, No. 9/10, May, 1939, p. 231, figs. 5*).

Trial to find a formula for the necessary power in milling. The Committee accepts the formula of "Schlesinger," Director of Research Department (published in "Werkstattstechnik," 1931, p. 409, and in his book "Die Werkzeugmaschinen," 1936, p. 28 and 455) on the basis of the "Mittenspandicke," that is the thickness of the chip in the middle of the arc of cutting

$$h_m = \frac{s'}{n \cdot z}\sqrt{\frac{a}{D}} \quad \text{and for the power of cut in kW} = N_{eff} = \frac{K_m \cdot a \cdot b \cdot s'}{60 \cdot 102 \cdot 1{,}000}$$

SHEET IRON WORKING.

The Formation of Contoured Sheet Metals by Stretching. (*Engineering, Vol. CXLVII, No. 3825, May 5, 1939, p. 526, figs. 5*).

In light plating construction, such as that of motor-car bodies, aeroplane fuselages and wings, and guards for moving machinery, the older methods of laboriously hammering the parts into shape is rapidly giving place to forming in the hydraulic press. In order to secure the advantages of rapid, uniform and accurate production which are characteristic of hydraulic pressing, without having to sink capital in a large stock of blocks and dies. A process consisting of stretching the sheet metal over wooden formers has been developed (junkers). Apart from the saving and convenience of a wooden former the stretching machines are, in general, much simpler than the usual hydraulic press. The figures illustrate : aeroplane wing-tip in press, 150-ton press set up for wide work ; 150-ton press set up for narrow work ; pattern for hand-finished work in press, press with tilting table. It is not claimed that stretching is a process that can be carried out with unskilled labour. The operator must be able to judge when the maximum extension of which the material is

capable has been reached and must be able, if necessary, to divert the stretching from one area to another by cutting the metal in the region of the clamps. The formers, or patterns, are usually made of seasoned hard red beach, built up to shape by glueing and screwing much in the same way as a moulder's pattern is made, care being taken to see that the wood is disposed so as to stand the stresses due to the stretching of the sheet over it. It is recommended that all stretched parts should be annealed.

Scrap Strip Layout—Part I, by C. W. Hinman. (*The Machinist, Vol. 83, No. 16, April 22, 1939, p. 173, figs. 6*; **Part II,** *No. 17, May 13, 1939, p. 219, figs. 3*).

Part I.—Simple formulas for calculating the number of blanks per strip aid in determining an economical scrap strip layout. Correct design of the scrap strip is the first step in designing a blanking die. To a great extent, the layout of the scrap strip determines the general design and dimensions of the press tool. Blanks to be formed should be positioned in the strip so that none of the bends will be less than 30° across the grain. Sharp cornered bends should be avoided if possible, unless the material is less than $^1/_{16}$in. thick and of high ductility. The " burr side " of a blank is the punch side. In bending operations it is advisable to place the blank in the die with its burr side up. Examples : By laying three cardboard blank outlines on the strip layout, the most economical use of material is obtained. When blanks are unsymmetrical about the centerline, special finger stops are required for double press runs. For finding the number of symmetrical blanks contained in a strip, the common method is to divide the length by the distance between blanking centers. Multiple blank dies. How many blanks per strip? Computing blanks. A scrap strip layout is especially important in the case of short strips to prevent excessive end-waste or spoiled blanks. Most efficient die operation and minimum scrap loss are assured in multiple blanking of larger orders of symmetrical parts by carefully working out the scrap strip layout and die openings.

Part II.—A scrap strip layout is essential to secure satisfactory design of tools for progressive die work. Intricate parts involving several blanking and forming operations are often made in multi-slide machines. The scrap strip for a sample shows the location and sequence of the various operations and emphasises the precautions to be taken in die layout. Sharp salients are produced on the blank shown without using frail projections in the die. A depression 1½ in. in diameter by ¼ in. deep in the part indicates that drawing should be the first operation in a progressive die. It is good practice to locate trimming punches in progressive dies so that they are not opposite, thereby avoiding a narrow neck in the die that will give difficulty in machining and hardening. Frail projections within a die should be eliminated if possible to avoid breakage. In progressive dies, the scrap strip determines the tool layout even to a greater extent than in other types of dies. Using the most economical scrap layout for expensive materials cannot be overstressed. This is particularly true where large outputs are involved. Several methods are given for computing the weight of material required per 1,000 blanks.

MANUFACTURING.

The Lysander in Production, by S. W. Hiscocks. (*Aircraft Production Vol. 1, No. 7, May, 1939, p. 226, figs. 17*).

The Westland Lysander is a two-seater high-wing, strut-braced monoplane. The construction of the machine is mixed, the front portion being made up of alloy tubes as used for the now obsolete Wapiti, and the rear portion of steel tubes. Some interesting machining operations are shown : a drilling jig for main wing spars ; riveting a main wing spar ; attaching the skin to the leading

of the main plane ; a main wing assembly jig ; a box drilling jig and the fuselage cross strut for which it is used ; a jig for tail-plane assembly ; riveting the skin on to a flap leading edge ; a fuselage main assembly jig ; a jig used for welding up the rear portion of the fuselage ; Kendall and Gent plano-miller machining axles before they are bent ; a special rig for drilling and facing bosses on the axles ; an assembly jig for the bomb wings ; cutting the slot in a web of a lift strut spar.

De Havilland Variable-pitch Airscrews. (*Machinery, Vol. 54, No. 1388 and 1389, May 18 and 25, 1939, p. 189, figs. 23 and p. 225, figs. 19*).

I.—Constructional features, methods and equipment employed. A finished spider for the de Havilland 20° airscrew and the forging from which it is produced. Production operations on the spider. The accuracy of the spider in respect of certain important particulars is checked on a simple fixture.

II.—Fine limits and a finish of a high order are called for in the production of the components for the various types and sizes of variable-pitch airscrews. The illustrations show : machining operations on the barrel ; boring the blade sockets ; grinding the blade sockets. The production of the cylinder ; drilling and counterboring the bosses ; inspection fixture for the cylinder.

The Manufacture of Airscrews. (*Machinery, Vol. 54, No. 1385, April 27, 1939, p. 93, figs. 24*).

Methods employed by Rotol Airscrews, Ltd., Gloucester, in the production of constant-speed hydraulically-operated units. The airscrew is of the three-bladed type, the blades being of magnesium alloy. The blades fit into sockets in the steel hub shell, within which the operating mechanism is housed. A steel driving centre is mounted directly on the engine airscrew shaft, and, being secured to the hub shell by a number of taper bolts, transmits the engine torque to the hub shell and thence to the blades. The main components of the airscrew. Production process sheets. Operations on the hub shell. The production of airscrew blades. Method of profile milling the cambered surface of the airscrew blade. Set-up for profile milling the root end of the blade. Profile milling the edges of the blade from a master. Fixture of checking blade form and dimension. Polishing a blade to obtain accurate balance against a master. Testing the blade for balance with the master in the vertical position. Set-up for the threading operation on the blade root. Inspecting the blade thread form on a projector. The final test for balance on the assembled airscrew.

The Production of Cold-rolled Strip and Sheets by the Continuous Process. (*Machinery, Vol. 54, No. 1386, May 4, 1939, p. 142, figs. 5*).

Equipment and processes at the Ebbw Vale Works of Richard Thomas & Co. Ltd. Modern requirements call for, in addition to rapidity of output, a standard of flatness and finish which will remove some of the difficulties of deep-drawn press work, and provide a suitable base for the extended use of metal decoration. The main factors which govern the rolling efficiency and provide this requisite control of product and precision of gauge are the use of relatively small rolls of the requisite contour and temperature, four-high mill construction, the correct spring of the rolls, heavier housings, and precision roll necks and bearings ; suitable physical characteristics, temperature, and condition of tension in the material ; lastly, the fine-measuring apparatus for checking the limits of the material when passing through the rolls at high speed. Diagram showing diminishing convexity of the strip at each pass. What distinguishes the method of continuous rolling from that ordinarily employed is that the material is simultaneously engaged in every mill-stand while rolling any particular piece, instead of being clear of each mill before it enters the next.

The blooming mill, the hot strip mill. The importance of de-scaling. Hot strip finishing. The cold process. Continuous pickling. Continuous cold-sheet mill. Standard tolerances for motor-car sheets : nominal thickness of sheet. Tolerances on sheets under 3 ft. wide. Tolerances on sheets 3 ft. and over. Tube annealing furnaces. The other portion of the output from the pickling line passes to the tin-plate department in the form of coils. Five-stand tandem cold-rolling mill, showing electric flying micrometer, the reading of which is shown on dials. The strip is recoiled after cold-rolling. Plate to be coated with tin in the Poole-Davis tinning equipment is pickled in a white pickling plant and loaded into water boshes for transporting by special mobile crane to the tinning plant. Nine 64-in. two-way and one 75-in. two-way Poole-Davis tinning machines are provided, as well as eight six-way tinning machines. In each of these units plate is automatically fed, classified, tinned, cleaned, and piled.

Full information as to operating conditions is supplied by the instruments on the control-board, such as indicating the power each motor is taking, the speed of each mill, and the temperature of the hot metal at various stages of rolling. A reference also is made to the makers of the plant, to whom is largely due the high degree of engineering perfection to which rolling mill machinery has been brought.

Rationalisierung durch Betriebsueberwachung (*Measuring and checking during the manufacturing in large quantities*), by W. Kniehahn. (*Maschinenbau, Vol. 18, No. 9/10, May, 1939, p. 219, figs. 10*).

A well organised checking of all parts, all groups and finally the assembled apparatus or the ready machine is indispensable, particularly in " mass " production. The consequences for an increased output are deduced. The economic side and the possibility of checking great quantities of small parts (punchings, stampings, etc.), e.g., in making watches, telephones, typewriters. The dial indicator. Automatic checking. Suitable and unsuitable application of tolerances. Systematic samples taken at random. Mounting and setting-up. Expenses.

MATERIAL.

G.K.N. Ledloy Steel. (*Machinery, Vol. 54, No. 1378, May 11, 1939, p. 172, figs. 4*).

A metallurgical development of considerable importance is the introduction recently by the Exors. of James Mills, Ltd., Bredbury, of their G.K.N. Ledloy steels. By the use of a metallic addition, namely lead, this concern claim that they are able to improve the machinability of the majority of steels by as much as 60% without in any way affecting their general properties. The latter claim also holds good even when the material is heat-treated. It has proved possible to ensure a homogeneous distribution of the lead, thus giving uniformity in the machining characteristics from cast to cast. Microscopic and X-ray examinations, also checks made on the electrical properties, all indicate that the lead is present in the metallic state and in very finely divided form. The pearlitic structure is very similar to that of ordinary .40% carbon steel and does not indicate any modification due to the lead content. Photomicrograph of etched specimen of normalised .40 carbon G.K.N. Ledloy steel. Curves showing effects of the finer size of Ledloy steel on hardness penetration. Results of mechanical tests on acid quality steel specimen to Admiralty specification No. 159 at temperatures up to and beyond the blue temper range. Mechanical tests on basic open-hearth G.K.N. Ledloy specimen normalised to Admiralty specification No. 159.

Les Aciers et les Fontes au Nickel-Chrome-Molybdène (*Steels and castings with nickel-chrome-molybdenum*), by M. J. Cournot. (*Revue du Nickel, Vol. 10, No. 2, March-April, p. 38, figs. 26*).

Influence of the addition of Molybdenum on the nickel-chrome steels. Variation of Brinell-hardness to depth for different brands of steel after hardening and drawing the temper. Suppression of brittleness after tempering. Improvement of the whole qualities. Forged and laminated steels with nickel-chrome-molybdenum. Standards of steels of the S.A.E. and the British Standards Association. Various applications : casehardening by carbon, nitriding ; automobile and aeroplane ; bottles with compressed gases, stainless steels.

Ni-Hard in the Foundry. (*The Nickel Bulletin, Vol. 12, No. 5, May, 1939 p. 97, figs. 6*).

Ni-Hard is of importance to the foundry itself, for there the handling of large quantities of sand, coal, and coke and the use of abrasives for cleaning castings give rise to very severe wear and tear of plant, so severe, indeed, in some cases, as to call for daily replacement. Examples : Speed sand conditioning machine in which the whole segments are made in Ni-Hard. Worm castings for conveyor for handling abrasive materials. Ni-Hard sand slinger impeller cups before and after use. Sand blast nozzles. Sand blast table plates after 116 days' use. Shot impeller blades from airless cleaning machine after use. The blades have been in service as follows : (I) Ni-Hard after five and a half hours. (II) Ni-Hard after eighty-one hours. (III) White iron after five and a half hours. (IV) White iron after twenty-three hours. Balls for ball mill for coal pulverising equipment. Ni-Hard is not much more expensive than the materials normally employed and the economies which it can bring generally far outweigh its extra initial cost.

MATERIAL TESTING.

Radiography—An Aspect of Non-Destructive Testing, by V. E. Pullin. (*The Journal of the Institution of Electrical Engineers, Vol. 84, No. 509, May, 1939 p. 535, figs. 35*).

The examination of structures directed to the discovery of flaws and defects, by X-rays and radium must be regarded as a part of the whole subject of non-destructive testing. X-ray tube on overhead trolley system and 600-kV X-ray equipment at Radiological Laboratory, Woolwich. Results obtained without screens. Results obtained with lead screens. With the widespread adoption of light alloy castings, particularly in aircraft construction, the use of visual X-ray examination has increased considerably in the past few years. Specially designed equipment is essential for this work because experience has shown that visual examination can only be efficiently carried out if the specimen is kept in constant movement. Of late years radium has been extensively used as a supplementary agent in radiological examination of metals. It has many advantages and it also has disadvantages. Radiographs of a 2½-in. weld. Radiograph of a heavy material inside a light alloy tube (without screen). Radiograph by radium of battery grid (lead alloy), showing holes and cracks. Radiograph by radium of 3½-in. aluminium alloy casting showing porosity. Exposure one and a half hours at distance 28 in. Radiograph by radium of zinc-alloy rings, showing porosity. Radiograph by radium of experimental casting of three brass cogwheels. Radiograph by radium of aluminium bronze brush-holders. (Thickness of this specimen varies from ½ in. to 2 in.) X-ray crystal analysis. The fact that most solid materials are crystalline means that they lend themselves to special investigation by the method known as X-ray crystal analysis. Sketch illustrating the use of radium

in locating the end of a crack near a vital wall. Sketch illustrating the use of radium in the examination of a turbine casting. Complementary methods of non-destructive testing.

Non-Destructive Testing, Based on Magnetic and Electrical Principles, by R. Berthold. (*The Journal of the Institution of Electrical Engineers, Vol. 84 No. 509, May, 1939, p. 529, figs. 17*).

(1) The magnetic-powder method, physical principles, excitation of the field, technical application : (a) Castings. The flaws which can be indicated by means of the magnetic method in grey cast iron, steel, and tempered cast steel, are slag inclusions and cracks near the surface. Cracks will most frequently be found to occur in those areas in which the diameter of the section changes. They are usually due to uneven cooling during solidification. (b) Worked objects and articles with treated surfaces. Slag inclusions, cracks, or folds, may occur as a direct or indirect result of distorted holes in objects which have been worked (drawn, rolled, forged, or pressed). These flaws may be at any depth, but they can only be shown up magnetically when they are near the surface.

A common use of the method is the testing of rolled plates for the presence of folds. The principal sphere of application of the magnetic-powder method is the examination of objects of which the surface has been treated (grinding, hardening). (c) The testing of joints. A special use of the magnetic-powder method of investigation is the testing of the rivet holes in order to detect any cracks between the holes. These frequently occur in boilers as a result of caustic embrittlement. (d) The testing of small objects. The examination of small parts can be made considerably more economical by separating the various stages of the examination—v.z., magnetization, spraying, and examination. (e) Demagnetization. All articles which are eventually used as moving parts, or in moving parts, particularly those to be used in aircraft, must be very carefully demagnetized after testing. A demagnitization apparatus, of the type referred to, is illustrated. Metalloscope, magnetic picture and image of the etched surface of a steel casting with very fine slag inclusions. Surface showing indications made by means of magnetic powder. Testing equipment for the detection of transverse and longitudinal flaws in wheels. Bearing showing hardening cracks with 700 amp. (a.c.) flowing. Section of a gear with transverse crack. Tested by the impulse method. Examination equipment for steel cables. (2) Magnetic inductive method. Instruments with movable coils. Equipment with stationary coils. (3) Measurements of dielectric losses. A non-destructive method of testing based on purely electrical principles is the measurement of dielectric losses.

The Non-Destructive Testing of Materials by Electrical and Magnetic Methods, by A. P. M. Fleming and B. G. Churcher. (*The Journal of the Institution of Electrical Engineers, Vol. 84, No. 509, May, 1939, p. 519, figs. 18*).

Modern physics has arrived at the conclusion that fundamentally all matter and all physical phenomona are electrical manifestations. The practical development of electrical and magnetic methods has, however, been mainly due to the very specific, exact, and convenient manner in which electrical quantities, and hence those derivable from them, can be controlled, the enormous range over which they can be varied, and the precision with which they can be measured. Electrical properties of materials : resistivity, permittivity and power factor ; thermal properties of materials, magnetic properties of materials ; magnetic crack detection. Bars before and after testing. Magnetic crack detection. Spring after test. Portable transparent crack detector. (The detector is shown placed over a section of bar material

which had been previously magnetized circumferentially). Magnetic crack-detection equipment for bar materials up to 12 ft. in length. Detection of flaws in steel by magnetic methods. Methods of testing metallurgical conditions, acoustical properties, vibration-attenuation properties, radiation and electrochemical tests.

Surface Defects in Engine Parts, by K. Kornfeld. (*Aircraft Engineering, Vol. XI, No. 123, May, 1939, p. 194, figs. 36*).

A Polish engineer's views on the effect of surface finish upon the life of an aero-engine. A selection of the great many samples might be given : Fatigue fracture of a spring, issuing from a crack along the wire ; cross section through injury on valve. Breakdown of thinner layer (nitrided) at an agglomeration of carbides. Damage on a valve. Inclusion on valve disk. Crack on valve-stem. Defect of material (oxydized scratch). Cross section of fissure oxydized during heat-treatment. Decarburization on surface of piston wrist-pin. Slag inclusion washed out by etching. Stress lines in a connecting-rod forging caused by over-deep marking with blunt dies. Local filing out of inclusions makes it possible to utilize an engine part. The risk of damaging an engine as a result of defects in its parts is so great that even a very costly control system is fully justified. Vigilance during inspections should be exercised by effecting the most rigorous control and by drawing attention to all shortcomings found. Care should not, however, go so far as to reject parts with innocuous defects.

Some Aspects of Engine Wear, by H. H. Jackson. (*Aircraft Engineering, Vol. XI, No. 123, May, 1939, p. 190, figs. 19*).

Examples of wear caused by abrasion, seizure and corrosion as opposed to the effects of impact. Chromium plating in cylinder bore, showing porous nature of deposit. Excellent bond between chromium and fine grained cast iron ; section of plate cylinder bore showing effect of an unsound region in cylinder casting ; section of stellited exhaust valve-seat. Two distinct layers of stellite are shown and the scarifying action of the flame may be traced ; section of exhaust valve-head tip after welding of stellite and 80/20 nickel-chrome alloy, disposition of these materials for minimizing valve wear and corrosion by exhaust gas are shown. Both alloys are readily welded and will form excellent bond during fusion. Photomicrograph of junction of stellite and 80/20 alloy on valve tip, showing perfect bonding with preservation of valve form. " Burnt stellite " with separation of coarsely acicular constituents, with subsequent embrittlement and weakening of the deposit. Abnormal penetration of stellite into austentic steel base, showing fusion in stellite into the grain-boundary cleavages. Bronze valve-guide-showing coarsely crystalline material with extensive planes of weakness, liable to tear in service. Distortion of crystal structure of bronze bearing material due to effect of cold work during drilling and broaching. This work-hardening effect is a feature of all machined bearing surfaces of phosphor bronze, gunmetal, etc. Surface hardening ; bearing metals. Experience in the possibilities of locally heat-treated engine components has not yet been generally gained, but it would appear that such a process would have distinct advantages over carburizing.

The Spectrograph and the Quantitative Analysis of Metals, by F. G. Barker. *The Engineer, Vol. CLXVII, No. 4348, May 12, 1939, p. 601, figs. 14*). (Abstract of lecture : Iron and Steel Institute, Institute of Chemistry—Joint meeting at Sheffield).

General view of Hilger large quartz spectrograph and equipment in the Admirality Laboratory at Sheffield. For the analysis of most non-ferrous metals and alloys, the medium size is generally satisfactory, but for the analysis

of iron and steel the large instrument is essential on account of the great number of iron lines which appear in the spectrum. It consists essentially of a heavy iron stand, on which the optical system and controls are mounted, enclosed by a metal dustproof cover, and also an electrode stand, slit, and camera. The instrument is so designed that the complete spectrum can be examined in three sections of about 10 in. long. A diagram of the optical train is shown. Details describe the slit, plate holder, electrode stand, polarity, alignment of light. Standard conditions for the arc spectra, qualitative examinations of spectra of : copper, brasses, bronzes, cupro-nickel, monels, aluminium and alloys, iron, steel. " Judd Lewis " comparator, used for the examination of spectrograms. The quantitative spectra. Samples of brass which contain tin and lead. Log spector wedge. Hilger photo-electric microphometer, used for the evaluation of spectrograms. Photo-electric readings of arc spectra of 14 samples of steel containing 2.5 to 4.4% of nickel. The " dry " method of investigation is very exact and quick and leaves nothing to personal judgment.

MEASURING METHODS.

Verification du Pas des Vis-Meres (*Verification of the pitch of lead screws*). (*La Machine-Outil Française, Vol. 4, No. 14, May, 1939, p. 153, figs. 2*).

Apparatus of the " Somua " Machine Tool Works to check lead screws and threads of different lengths from 2 in. up. The greatest length is 8 in., but the arrangement allows to put accurately 8 to 8 in. up to each desired length. The lead screw is resting either on V-blocks or in half bearings open on top.

ORGANISATION.

Organisation—Design for Modern Business, by F. E. Raymond. (*Transactions of the A.S.M.E., Vol. 61, No. 4, May, 1939, p. 291, figs 3*).

Questions of organisation for large-scale enterprises are of increasing importance. Decentralisation, in contrast to centralized authority, may not only facilitate leadership, but also broaden the organisation structure to draw administrator and worker closer together, materially enhancing their unity of purpose. Recent developments point not only to an increasing functionalisation of administration, but also to the reversal of the long accepted pyramidal structure of management where the work group becomes the unit of management and the superstructure of organisation must be justified on the service it renders these units. Historical implecations ; present status of organisation ; need for dynamic conceptions of organisation ; specialisation ; functional components ; facilities, functional definition ; functional development ; functional correlation ; functional integration and lateral disintegration ; co-ordination ; authority and accountability ; lines of delegation ; facilitating co-ordination ; factors of co-ordination ; facilitating leadership ; recent developments in business organisation ; practical aspects of organisation.

POWER, DRIVE.

Elektrische Antriebe von Werkzeugmaschinen (*Electric drive of machine tools*), by Weigel. (*Maschinenbau, Vol. 18, No. 78, April, 1939, p. 167, figs. 9*).

The electric drive of lathes is dealt with, and only from the experience of Siemens Schuckertwerke-Berlin, Germany. Uniform output, speed regulation. Direct-current regulation drive for light and medium lathes. Direct current drive for heavy lathes. Example : Double centre lathe. The use of " electric shafts," which consist of automatic regulation of two or more motors, the revolutions of which must be absolutely synchronised. The electric brake for " standstill." The change of the direction of turning, the frequency of revolution changes.

PSYCHOLOGICAL INVESTIGATION.

Psychological Factors in Accident Causation, by C. A. K. Oakley. (*Industrial Welfare, May, 1939, p. 187*).

Psychological factors are prominent in the causation of the majority of accidents. Almost half the people in Great Britain have an accident every year. The chief differences between major and minor accidents are in the consequences. Minor accidents are merely those accidents which by good luck did not have serious consequences. A man has an accident because (a) he was unaware that he was running a risk and was unable to or did not take the necessary precautions ; (b) he was aware he was running a risk and was unable to take the necessary precautions ; (c) he was aware that he was running a risk and did not take the necessary precautions. The most important items are : Safety habits ; accident proneness. During recent years the greatly increased application of time and motion study in British factories has focussed attention on the need for improving methods of work. Finally there are accidents which seem to be attributable to lack of concern on the part of the persons who caused them. Accidents of this kind are so stupid that one's first reaction is to wonder whether the level of intelligence of the individuals concerned is not below average. Frequently the person who suffers the consequences of an accident is not the person who was responsible for its happening.

RESEARCH.

Das Schwingungsverhalten eines Gusseisernen und eines staehlernen Drehbankbettes (*The Character of oscillation of a cast-iron and a " fabricated " lathe bed*), by Kienzle and H. Kettner. (*Werkstattstechnik and Werksleiter, Vol. XXXIII, No. 9, May 1, 1939, p. 229, figs. 17*).

The static conduct ; the behaviour of oscillation ; advantages of fabricated steel beds in comparison to cast-iron beds. In a machine tool there are two groups of exciters of vibration (a) the gear-box ; (b) the tool and the workpiece, which excite a vibration-impact in cutting, in tearing off each chip. Scheme of trials, execution of tests, the behaviour of the bed itself, the behaviour of the assembled lathe, spatial vibration graphs of the lathe with fabricated steel bed. Cutting tests ; result : (1) Fabricated steel beds are useful for the lathe design without decreasing the quality of the machine. (2) The same static and dynamic rigidity (as for cast iron) can be reached for steel beds with considerable savings of material. (3) The behaviour of vibration is better both regarding the amplitude of vibration and regarding the damping with steel beds. (Influence of the welded joints). (4) The frequency of vibration can be increased considerably where the fabricated beds of steel are of a shape adapted to welding. (5) The appearance of vibration is of increasing influence with quick running lathes for fine work.

Schallbekaempfung in Betrieben (*Silencing devices in the workshop*), by E. Lubcke. (*Werkstattstechnik und Betriebsleiter, Vol. XXXIII, No. 10, May 15, 1939, p. 253, figs. 26*).

Reduction of noise in workshops is necessary : (1) Because the noise may have a detrimental influence on the hearing and consequently on the entire human constitution. (2) Because elastic oscillations may provoke errors in production. Measuring of sounds. Investigation of the efficiency of sound by the field and by the space of sounding. Scale of measurement. Strength of sound and sensitivity. Silencing of vibrations of foundations. Statement of frequency. Numerical values to the demands for reducing noise. Methods for diminishing noise. Noise from electrical machines. Field of sound of two direct-current motors, each 800 kW, 275 r.p.m. full load. Noise from a two-

stroke cycle engine. Noise from electrical machines. Field of sound without and with machine shield. Silencing of sound by the machine shield with fixed swallow plates. Measures for buildings. Short statements concerning instruments for measuring.

SHOP, SHOPS MANAGEMENT.

Scheduling Die Repairs Saves 15%, by T. W. Chantley. (*Factory Management and Maintenance, Vol. 97, No. 5, May, 1939, p. 57, figs. 2*).

The Westinghouse Electric & Manufacturing Co., Sharon, Pa, have studied the operation of dies and calculated economical runs in pounds of stamping. They have impressed upon operators the need for the removal of dies from presses at the point where they get the best production with the least repairing.

SMALL TOOLS.

Die Design and Construction, by C.R.C. (*Machinery, Vol. 54, No. 1389, May 25, 1939, p. 237, figs. 7*).

Details of gauges, scrap cutters, and shedder pins for return-type blanking dies. Diagrammatic view illustrating the action of scrap cutters. Types of scrap cutter ; typical retractable gauge pin ; the shear type of scrap cutter ; the notch type of scrap cutter ; the chisel type of scrap cutter ; shedder pins ; diagrammatic view illustating an instance where the shape of the blank is such that the die sections would be too weak if the ordinary drop-through die were used.

SURFACE TREATMENT.

Investigation and Modern Ideas on Enamel Control, by G. H. Abbott. (*Sheet Metal Industries, Vol. 13, No. 145, May, 1939, p. 665, figs. 4*).

History : Early English enamel. Top, Bilston tea-caddies and sugar canister, about 1760. Battersea toilet box 1750 ; present day research ; organisation and research ; raw materials, enamel compositions ; thermal expansion of enamels ; expansion apparatus ; scientific methods ; comparison of observed and calculated values of expansion coefficient of an enamel : chemical analysis of frit ; revised composition, expansion factors, estimated expansion coefficient. Equal in importance to the thermal expansion and contraction of enamels is their property of fusibility. The softening of enamels at moderate temperatures permits them to be fused evenly on the metal, and the working range of the firing process is governed by this property and the character of the metal base. It is important that the fluidity of the enamel during firing should allow the ready escape of occluded air and any gases formed at the metal surface, thus preventing the formation of blisters.

WELDING, BRAZING.

Machine Tool Fabrication by Welding, by A. Kershaw. (*The Welding Industry, Vol. VII, No. 4, May, 1939, p. 140, figs. 3*). (Conclusion of article in April, 1939 issue).

Design and drawing office procedure on openside planer. The kinetic energy of the structure is only three-fifths of that of the cast-iron structure, thus reducing the deflection due to tool impact which is usually very noticeable on opens de planers. The deflection of maximum slope of such a column is not easily calculated, but a direct comparison may be made with the cast-iron column by finding the neutral axis and considering the column as a simple beam fastened at one end and subjected to a maximum load. The deflections

are for welded steel 0.0004 in., for cast iron 0.0006 in. The welded steel column will give a much smaller deflection than the cast iron, and it is only natural to infer that the excess of weight in the cast-iron cross-slide has an additional detrimental effect. The cross-slide and strut shows the greatest saving in weight but are, nevertheless, the most expensive part of the machine to fabricate, being subjected to higher dynamic stresses than any other part of the machine. The depth of the throat at the junction of column and base is increased to 42 in. as against 24 in. in the cast iron machine, all column stresses are removed from the bed side wall and no interference with the driving shaft or its bearing is probable. The use of a standard heavy beam with top and bottom added flanges is cheaper than building a welded plate girder unless special nose sections can be obtained which reduce the fit up and welding time. It is noticeable that in spite of the 9,100 lb. added to the machine weight by the girder base, the total weight of the machine is still 25% less than that of the cast iron type while a definite improvement is obtained by reduction of deflection under load and the unbreakable permanence of a steel construction. Calculation of weld values ; the number of runs per weld ; distortion in welding. A theoretical knowledge of what may happen due to uncontrolled heat effects in a welded joint is a great help in devising methods to combat such movements, with a view to the prevention of distortion.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, TEMPERING, CASE-HARDENING.

The Hardening of Light Metal Alloys by Heat-treatment in the Electric Furnace, by Otto Gegenbach, V.D.E. (*Aluminium and the Non-ferrous Review, Part I, April, 1939, Vol. 4, No. 5, p. 143, figs. 9, Part II, May, 1939, Vol. 4, No. 6, p. 167, figs. 9*). *And discussion.*

Part I : Short description on principle of the tempering process and its importance. Discussion regarding both the possibilities for homogenisation, annealing (salt bath furnace/circulating air furnace).

General considerations : (1) Heating-up time ; (2) soaking time ; (3) height of temperature ; (4) accuracy of temperature ; (5) the changing-over of the annealed material from the furnace to the tempering trough ; (6) ageing.

Kinds of furnaces : (*a*) Salt bath furnaces. (*b*) Circulating air furnaces for : (1) Light metal casting ; (2) pressed and forged parts (intermittent and continuous annealing process) ; (3) rods, bars, profiles ; (4) bands, wires, small parts ; (5) sheets (details regarding production, duration of annealing, heating up time, and uniformity of the annealed part).

Temperature measurement and temperature regulation. Comparison between a salt bath furnace and circulating air furnace.

ACCOUNTING.

A Review of the Principles and Practice of Cost Accounting, by W. E. Harrison. (*The Cost Accountant, June, 1939, Vol. 19, No. 1, p. 15*).

Discussion of all important items regarding the functions of the cost accountant which are : (*a*) Accounting for all income and expenditure on the basis of the productive and distributive activities of the business ; (*b*) the relating of these items to the resulting production ; (*c*) the detection of all avoidable waste, whether of materials, labour, or overhead facilities ; (*d*) the development of cost standards; (*e*) the comparison of the costs of alternative methods, etc. ; (*f*) the preparation of economic selling prices.

Long term policy must be designed to make the equation—number sold X (selling price minus total cost) i.e. " Net profit " as high as possible, whilst short term policy must attempt to make the equation—number sold X (selling price minus out-of-pocket cost(i.e. " Contributions " as high as possible. Wage incentive methods, high wages for a good week's work, comparison of the individual with the group system, the importance of team work. " Direct materials." " Overheads." " The unit of work which forms for a particular work the most convenient basis for costing purpose." " Are uniform costing systems for industries an unmitigated benefit ? " Uniform costing systems are to be devised to benefit the industry, whereas the individual system is designed to benefit a particular business. Uniform systems of costing within any industry should be drawn up by a " Cost dictator." The management period. Outlook towards a trade cycle in industry.

Foundry Costs, by I. Haldane. (*The Cost Accountant, June, 1939, Vol. 19, No. 1, p. 4*).

The foundry costs include foundry planning, pattern shop and pattern stores, and foundry proper. Article deals only with the foundry proper, and is confined to non-ferrous foundry practice. The three main operations are : (1) Moulding and core-making ; (2) melting ; (3) dressing. The first function is performed by machine, i.e., cleaning of used sand, mixing with new sand, addition of water and milling ; a constant supply of prepared sand is always available for use. The second function, the melting, includes all operations from raw material to the liquid mixture. The third function, the dressing operation includes the removal of the cores from inside the casting, and the removal of runners, risers, or any rough projections which may be left on the surface.

A diagram shows the sequence of operations in the foundry. It is an error to assume that the total foundry cost bears a definite relationship to weight only. The main headings under which data is collected for the preparation of the costs are : Direct material : (1) Metal cost. Direct labour : (2) Moulding, core-making, and closing wages. Indirect charges : (3) Melting cost ; (4) dressing cost ; (5) indirect charges of (*a*) core-making department (*b*) moulding department.

A diagram shows an analysis of typical elements of foundry cost in more detail. Another figure shows how each item of expenditure is either charged to one class of overhead or allocated between two distinct overhead groups. An example of two castings equal in weight, and with equal total direct wages, illustrates the effect of analysing the direct wages and indirect charges in order to show separate costs for moulding and core-making.

BELTS AND ROPES.

The Application of Transmission Belting—V, by H. Stuart Jude. (*Power Transmission, June 15, 1939, Vol. 8, No. 89, p. 279, figs. 2*).

Correct the horse-power for arc of contact. Chart showing arc of contact correction factors. Correct the horse-power for the drive layout. Table showing the applicable correction factors for various forms of drive layout. Correct the horse-power for the small pulley diameter. Find the most suitable type of belting. Table showing suitability of different constructions of belting in various conditions of service. Find the belt width and thickness.

COOLANT, LUBRICANT.

Lubricity, by Fletcher Miller, Ltd., Hyde, Eng. (*Lubricity, April, 1939, Vol. V, No. 20, p. 3*).

Water hardness and its effect on soluble oils. The absorption of carbon by iron. Town water supplies in Great Britain and Eire—selected hardness figures. Pivot lubrication under review. Measurement : by the King's arm. Oil in the news.

EMPLOYEES AND WORKMEN.

Medical Services for Modern Industry, by Dr. Howard E. Collier, M.C. (*Industrial Welfare and Personnel Management, June, 1939, Vol. XXI, No. 246, p. 211*).

What kind of contribution ought medicine to be making to industry ? There are eight medical inspectors of factories and one medical inspector of mines. There are less than 100 whole-time industrial medical officers. There

are about 2,000 examining and certifying factory surgeons and some hundreds of part-time medical officers serving in factories in a variety of ways. Taking into consideration the fact that there are nearly 250,000 independent factories, workshops, docks, and warehouses in this country at the present time, it seems that, if a medical service has any valuable contribution to make to industry and to the worker, that contribution is not being adequately made. The emergent structure. Value of works medical service. Executive functions. Organisation.

(1) *The whole-time medical officer*—in every firm employing over 7,000 to 8,000 persons. (2) *The group factory service*—one medical man to a group of factories employing, say, up to 10,000 workers in all. If women are almost exclusively employed a woman doctor is often preferred. The medical department of the Home Office lays great emphasis upon its constant readiness to help in all industrial medical problems.

KINEMATICS.

Fabrication d'une came cylindrique destinee a etablir un contact suivant une fonction variable du temps (*Making a cylindrical cam to follow a movement of variable time-elements*), by I. Sapy. (*La Machine Moderne, Mai, 1939, Vol. XXXIII, No. 371, p. 393, figs. 3*).

A circuit of fluid must be closed during the varying fraction of a given time and opened during the remainder of the time of the cycle. The calculation, the graph, and the executed design of the cam are shown.

Reibradgetriebe als Steuer-, Mess-, und Rechengetriebe (*Friction gear as Governing, Measuring, and Calculating Drive-gear*), by A. Kuhlenkamp. (*VDI-Zeitschrift, June 3, 1939, Vol. 83, Bo. 22, p. 677, figs. 16*).

The theoretical foundation and the fundamental constructive performances are discussed of the various friction gear drives : (1) To steer ; (2) to measure the speeds and accelerations ; (3) to multiply the value of speed by a variable factor. The explanations are restricted to the constructions which are of practical importance for the direction of shooting (rifles, guns). Examples : Friction disc gear, friction calotte gear, way-speed drive, steering differential gear, friction disc drive as acceleration gear with one and two friction discs.

Leistungsverzweigung und Scheinleistung in Getrieben (*Branching of Power and Apparent Output in Gearing*), by H. v. Thüngen. (*VDI-Zeitschrift, June 17, 1939, Vol. 83, No. 24, p. 731, figs. 12*).

Discussion of the " branching " of power. Scheme for a differential gear. Flow of power in the differential gear. General construction of the branching of power. Consequences of such a branching to the design. Conception of " apparent output." For gears, which have a compensation gear, the calculation of the revolutions and the twisting moments by quantity and sign ($\pm$) is essential to find the correct dimensions of each single gear, because the flow of power is branching in the gearing. At first it must be clear in which direction the power is flowing in the single branches. Further, it must be examined for the simple differential gears without branching of power, if and in what quantity apparent outputs are existing within the gear. Statement of the methods of calculation to find these factors and practical consequences for the designer.

MACHINE COMPONENTS.

Rubber Mountings for Industrial Equipment, by Walter C. Keys. (*The Machinist, May 20, 1939, Vol. 83, No. 15, p. 248, fig. 1*).

Vibration of mechanism can be reduced by one or more of the following treatments : (1) By supporting on resilient mountings of proper flexibility to absorb the vibration instead of transmitting it ; (2) by rigidly securing to a very heavy foundation ; (3) by the use of counter-vibrators whose natural frequency is equal to the forced frequency of the mechanism. Rubber mountings are shown used under a motor to overcome vibration which would otherwise be transmitted to the bed of this machine tool. The anvil of a steam hammer rests on a rubber-mounted foundation block to reduce transmission of the blows to adjacent buildings and equipment. When used under favourable conditions, mountings may be expected to be in good condition at the end of at least six years.

MACHINE-TOOLS.

Werkzeugmaschinenpflege (*Careful Treatment of Machine Tools*), by E. Thiessen. (*Maschinenbau, June, 1939, Vol. 18, No. 11-12, p. 283, figs. 7*).

Lubricating arrangements, lubricants, service diminishes wear and power consumption. Automatic arrangements relieve the workman and are at the same time the most convenient. Good lubricants diminish friction, power, and wear. A systematic survey of all machines by a card-index system is recommended. Examples.

Massnahmen zur regelmassigen Pflege und Instandhaltung der Werkzeugmaschinen (*Measures for the regular Survey and Maintenance of Machine Tools*), by H. Hefft. (*Werkstattstechnik und Werksleiter, June 15, 1939, Vol. 12, p. 297*).

To-day the delays for new machines are up to two years and the expenses are enormous, therefore it is extremely important to maintain and to repair the existing machines. Card-index for checking : the machines, natural wear, mistakes of service, defects of make, distribution of repair hours to causes of defects. Co-operation between user and maker demanded. Information of the maker. Planning of survey by exact knowledge and registration of causes of damage.

Konstruktion und Lebensdauer der Werkzeugmaschine (*Design and lifetime of the machine-tool*), by H. Kiekebusch. (*Maschinenbau, Vol. 18, No. 11/12, June, 1939, p. 275, figs. 18*).

The life of the machine tool depends on by what means and for how long the accuracy and the efficiency of the machine can be maintained. Both depend on the wear of the parts which glide on each other. The strain by the cutting and deforming forces, however, is mostly negligible. Therefore, the most important demands are : rigidity of the uprights and the main working parts. Good selection of materials and correct size regarding wear. In addition the following are of importance : accuracy of guidances, their adjustment to wear, protection against chips. On account of quick interchangeability of worn-out elements a systematic standardisation of parts is of special importance.

MACHINING METALS (COLD).

Machines-Outils : Choix des vitesses de coupe (*Machine-tools : Choice of cutting-speeds*), by H. Caillon. (*La Machine Moderne, Vol. 33, No. 372, June, 1939, p. 449, figs. 2*).

Graphs to find either maximum output or the minimum of expense.

Untersuchung uber spitzenloses Genauigkeitsschleifen (*Investigation of centerless precision*), by E. Sachsenberg and R. Kreher. (*Werkstattstechnik, Vol. XXXIII, No. 11, June 1, 1939, p. 280, figs. 17*).

All trials were made with lengthwise feed not by plunging. Measuring instruments for the surface finish : the condenser-surface tester of *Perthen*. Influence of original excentricities, of height of piece, of angle of supporting lineal, of circular and longitudinal feed, of the inclination of feeding disc, of the shape of grinding wheel, of the depth of cut, of the shape and the diameter of piece, of the number of passages. The best grinding conditions.

Barrel Polishing, by Dr. E. G. West. (*Machinery, Vol. 54, No. 1393, June 22, 1939, p. 383, figs. 9*).

The old-time barrelling processes have been re-discovered. Considerable savings in cost have been obtained over the usual machine polishing process, varying normally between 60 and 90%, while in certain applications, barrel methods provide the only possible means of attaining the desired result. The methods in use to-day are reviewed with notes from the author's own experience, and divided into the following sections : (1) Purpose and advantages of barrel polishing. (2) Résumé of the theory of polishing and burnishing. (3) Discussion of the variables involved. (4) Practical data. (5) Developments. The principal methods are illustrated.

Cut-and-Carry Dies, by C. W. Hinman. (*The Machinist, Vol. 83, No. 19, June 17, 1939, p. 332, figs. 8*).

Progressive notching, perforating, embossing, drawing, forming and cutting off are done in a single press tool by carrying the evolving part along in the strip. First step in developing cut-and-carry progressive dies is to unfold the finished piece shown for a blank development. The blank development leads to a work plan and a preliminary sketch of the tooling. Insulation on wire or cable is prevented from being cut or worn when pulled through holes in apparatus, if a rolled and seamed hole is employed. A " rolled " hole is started by piercing and extruding with a single punch. With the extrusion placed down on the anvil it is rolled under and seamed.

Strip Location in Piercing and Blanking, by C. W. Hinman. (*The Machinist, Vol. 83, No. 18 June 10, 1939, p. 301, figs. 8*).

Pilots, hand or automatic stops, and means to press the strip firmly against the back gauge are essential to accurate relationship. If the pierced holes are not accurately located with respect to the blank outline, the press tool must be checked for construction errors. Blanking operations on automobile bumper guards. Deflection of punches in multiple perforating is avoided by making the punches of stepped lengths. Automatic stopping. Idle stations allow sufficient space between die operations to allow attaching the punches in a progressive compound die.

MACHINING (HOT).

Untersuchungen uber das Steigen des Werkstoffes beim Gesenkschmieden. (*Investigations into the rise of the material in drop forgings*), by J. Muenker and W. Lueg. (*Stahl und Eisen, Vol. 59, No 22, June 1, 1939, p. 649, figs. 27*).

Plan of tests. Principal description of the formation of the dies. Test apparatus and execution of tests with a 250 tons press and a 400 lb. drop hammer. Quartz measuring gauge as instrument. Results of trials: (1) Test with lead: influence of the shape of die, of surface quality and speed of deformation regarding the rise of material within the die and regarding the press work. (2) Tests with steel: influence of drop of temperature (from 1,200° to 800°C.) between piece and die as well as of speed of deformation to the rise of material and consumption of power. Investigation into the flowing of the material within the die. Influence of: grade of deformation, rounding of the corners, inclination of walls, friction of the surface of die.

Toggle-Operated Rubber-Moulding Press. (*Engineering, Vol. CXLVII, No. 3829, June 2, 1939, p. 658, figs. 4*).

The subject of the article is a single toggle-operated press for moulding and vulcanising small rubber parts incorporating a metal insert. The press is shown in the open and in the closed positions. The actual load on the mould is, making a very generous allowance for friction, 300 tons. A direct-acting ram to give the same mould pressure would, if the working pressure were 1,500 lb. per sq. in., require to be 24 in. in diameter, or if the pressure were 750 lb. per sq. in., would have to be 34 in. in diameter The reduction in the size of the press by employing the toggle gear is at once apparent from these figures. A section drawing shows details of design. In the newer industry of plastic moulding, the press should prove very useful, as the parallel movement provides the straight-line loading. It is manufactured by Messrs. Rogers, Wilson & Comps, Ltd., Speaking Stile Walk, Birmingham.

MANUFACTURING.

Producing the Blenheim Bomber, by S. W. Hiscocks, M.I.Mech.E., M.I.A.E., F.R.Ae S. (*Aircraft Production, Vol. 1, No. 8, June, 1939, p. 263, figs. 31*).

The Bristol Works; manufacture of the main wing spar, centre and outer wing sections, flaps and tail surfaces, the fuselage. General arrangement drawing and data of the "Bristol Blenheim." Many details of manufacturing with jigs, fixtures and tools.

The Quantity Production of Airscrew Blades. (*Machinery, Vol. 54, No. 1391, June 8, 1939, p. 289, figs. 15*).

A high output is obtained by the use of special machines and the systematic application of power-driven hand tools in the airscrew shops of the de Havilland Aircraft Co. Ltd. Fifteen illustrations of machines, jigs, fixtures, and tools.

Production of Airscrew Components. (*Machinery, Vol. 54, No. 1390 June 1, 1939, p. 257, figs. 14*).

Some interesting operations at the Stag Lane Works of the de Havilland Aircraft Co. Ltd. A finished counterweight bracket for a 5,000 size airscrew. A bronze blade bush. Good photographs of jigs, fixtures and tools are given.

Ammunition Manufacture for the 3.7-in. Anti-aircraft Gun. (*Machinery, Vol. 54, No. 1393, June 22, 1939, p. 353, figs. 3*).

Operation of the round, the production of shell forgings, the machining of shell bodies, cartridge case manufacture.

The Manufacture of Cartridge Cases for 3.7-in. Anti-aircraft Gun Shells. (*Machinery, Vol. 54, No. 1393, June 22, 1939, p. 371, figs. 29*).

Press shop operations. Indenting operations. Sectional views showing stages in the base rolling operation. Typical gauges used in the inspection of the completed cases. Gauging fixture for checking wall and base thicknesses.

MATERIALS, MATERIAL TESTING.

The Testing of Sheet Metal Destined for Deep Drawing and Pressing, by J. D. Jevons, Ph.D.,, B.Sc., A.I.C. (*Sheet Metal Industries, Vol. 13, No. 146, June, 1939, p. 775, figs. 6*).

An attempt is made to describe a number of tests which have been used or proposed, and to discuss their merits, faults and limitations as an indication of deep drawing and pressing properties in as unbiased a manner as possible. (1) Chemical analysis. (2) Microscopical examination. Diagram illustrating five positions of the polished faces of micro-specimens relative to the direction of rolling. The influence of (1) degree of polish and (2) distance of micro-section beneath surface of 0.020 in. thick brass sheet upon the micro-structure revealed. (3) Hardness tests. Rockwell test. Vickers test. Brinell test Herbert pendulum test. Blister produced by bending and straightening steel strip containing an internal discontinuity. (4) Bend tests. Tour Marshall bend-test machine. (5) Slotted strip test. Diagram illustrating principles of slotted strip test.

Les Aciers et les Fontes au Nickel-Chromium-Molybdene (*Steels and castings with nickel-chrome-molybdenum*), by M. J. Cournot. (*Vol. 10, No. 2, March-April, 1939, p. 38, figs 26, and Vol. 10, No. 3, May-June, 1939, p. 66, figs. 13*).

Part I.—Influence of addition of molybdenum on the nickel-chromium steels. Variation of Brinell hardness in depth for different brands of steel after hardening and drawing the temper. Suppression of brittleness after tempering. Improvement of all qualities. Forged and laminated steels with nickel-chrome-molybdenum. Standards of steels of the S.A.E. and of the British Standards Institution. Various applications: casehardening by carbon, nitriding, automobile, aeroplane, railway, shipbuilding. Pieces exposed to great abrasion, dies. Normalised and heat treated steels, bottles for compressed gases. Stainless steels. Part II.—Cast steels of nickel-chrome-molybdenum. Chemical components. Qualities as functions of the tempering temperature after quenching in water of 840°C. Drop hammer head of Ni-Cr-Mo-steel of 4,8 to weight. Ni-Cr-Mo-castings. Valve boxes. Table of chemical components of many samples such as motor-blocks, crank-shafts, dies, gears, mills, rolls, machine-tool uprights, castings for high pressure.

The Effect of Nitrogen Additions and Heat-Treatment on the Proprieties of High-Chromium Steels, by E. W. Colbeck, and R. P. Garner. (*Engineering Vol. CXLVII, No. 3831, June 16, 1939, p. 726, figs. 7*).

The paper puts on record the results of an investigation into the manufacture, and the effect of heat-treatment on the properties, of high chrome

steels containing varying amounts of nitrogen. Treatment of ferro-chrome with nitrogen. Method of making the ingots. Experiments on forging the 25% chrome ingots. Mechanical testing of forged material. Impact tests. Effect of tempering on impact values. Tensile tests. It was found that the steels having nitrogen contents of the order of one-hundredth of their chrome content have considerably better properties than those with low percentages of nitrogen. For example, specimens from ingot X 408, water-quenched from 1,125°C., had a tensile strength of approximately 50 tons per sq. in., with elongation between 50 and 76% and a reduction of area between 5% and 6%. Microstructure heat resistance. Miscellaneous experiments. Effect of prolonged heat-treatment on grain size. Corrosion experiments. Machinability and fabrication. During the preparation of the many specimens for the mechanical tests used in the investigation it was consistently noticed that the high-nitrogen bearing steels were easily machinable, long free-cutting turnings being an invariable characteristic. Conclusions. The addition of nitrogen to high-chrome steels has a marked effect in refining their naturally coarse grain size. The best results have been obtained with steels containing between 22.5 and 28% of chrome, in which the nitrogen content is approximately one-hundredth of the chrome content and nickel is present in amounts of the order of ½ to 1½%.

Some Engineering Aspects of Cast Iron, by Carl H. Morken. (*Mechanical Engineering, Vol. 61, No. 6, figs. 4*).

Development of the structure of cast iron. Effect of adding alloys to cast iron. Heat-treatment of cast iron. Semisteel a misnomer. Specifications for cast iron. A few of the applications for which highly improved irons are available: (1) Mechanical strength. Tensile strengths up to at least 80,000 lb. per sq. in., without heat-treatment. (2) Strength combined with toughness, as expressed by the "resilience" figure or impact tests. (3) Of composition rendering the castings especially suitable for heat-treatment. (4) Controlled hardness. (5) Of definitely superior qualities for resisting each of many types of wear. (6) Improved corrosion resistance for a wide variety of reagents and conditions. (7) Heat resistance and ability to withstand even severe oxidizing conditions. (8) Iron that does not distort after machining, but which will retain accurately machined dimensions indefinitely. (9) Non-magnetic cast iron. (10) Iron of high expansion characteristics. (11) Iron of very low expansion characteristics. (12) Iron which is stable at extremely low temperatures.

Tensile, Compressive and Impact Properties of Nickel, Monel, "K"-Monel and Inconel. (*The Nickel Bulletin, Vol. 12, No. 6, June, 1939, p. 128,*).

Tables containing data on: (a) *Chemical composition*: Carbon, sulphur, silicon, manganese, iron, copper, nickel, aluminium, chrome. (b) *Physical properties*: *Tension*: Yield-strength, tensile strength, elongation, reduction of area. *Compression*: Yield strength, Brinell hardness, Izod, Charpy.

MEASURING METHODS.

Abnahmebedingungen fur Werkzeugmaschinen (*Acceptance test charts for machine tools*). (*Werkstattstechnik und Werksleiter*), *Vol. 12, June, 1939, p. 314, fig. 1*).

The German Standards Committee of Machine Tool Makers has published preliminary (Vornorm) acceptance charts: DIN 8605—tool-maker lathe;

8606—ordinary lathes; 8615—horizontal milling machines; 8625—radial drills; 8630—circular grinders. Regarding the tests to be applied, illustrations, gauges and methods, tolerances, these " Vornorm " charts correspond very closely to " Schlesinger Limits " The distribution in geometrical tests as principal measurements combined with a minimum of working tests has also been kept. The working tests for milling machines are entirely lacking. DIN—8601 is a very short preamble which is however, completed by giving for each item a broad detailed description, how the very simple testing tools, which remain always the same and are clearly illustrated, ought to be used by the expert inspectors.

Verification du Pas des Vis-Meres (*Checking of the pitch of lead-screws*). (*La Machine-outil Francaice, Vol. 4, No. 14, May, 1939, p. 153, figs. 2*).

Apparatus of the SOMUA-machine tool works to check lead-screws and threads of different length from 2 in. upwards. The greatest checking length is 8 in. only, but the arrangement allows for 8 in to 8 in. to be put up accurately to any desired length. The lead-screw rests either on V-blocks or in half bearings open on top.

Einsatz Photozellen im Betriebe (*The use of photocells in the workshop*). (*Werkstattstechnik, Vol. 33, No. 11, June 1, 1939, p. 289, figs. 6*).

Examples: Steering a transporting chain for motors and other goods, testing the correct clamping of a piece; automatic control of a hardening apparatus; starter.

PSYCHOLOGY.

Fatigue, by Francis A. Fox, M.Sc. (*Machinery, Vol. 54, No. 1390, June 1, 1939, p. 265, figs. 4*).

" Fatigue " is the term applied to the failure of materials under the application of repeated stress. The formulae are based on the theory of the elastic behaviour of metals, which in turn rests on certain assumptions. Some of these are: (1) That Hooke's law is obeyed, the loading curve coinciding with the unloading curve. (2) That the material has similar elastic constants in all directions—*i.e.*, is isotropic. (3) That the material is homogeneous—*i.e.*, that it contains no mechanical flaws or non-metallic inclusions. The " S-N " curve. The S-N curve whereby the endurance limit is determined. Where S = stress range, N = number of cycles of stress, E = endurance limit. Hysteresis. Mechanism of fatigue failure. The behaviour of materials subjected to the combined action of corrosive agents and of cyclic stresses is interesting and of great practical importance. Curves indicating the effect of corrosion on fatigue values for the same material. Principles in design of fatigue-resisting parts. Tests should be carried out in an atmosphere similar to that which the material will encounter in service.

STANDARDISATION.

Die Normungszahlenund ihre Anwendung. (*Standardised numbers and their application*), by O. Kienzle. (*VDI—Zeitschrift, Vol. 83, No. 24, June 17, 1939, p 717, figs. 10*).

Standard numbers of the metric system form the most comprehensive standard of all fundamental standards on the Continent. They consist of geometric series with the figure " 10 " as basis. With these geometric series, calculations, design, and general building-up are specially easy. Their

" security of hitting " is best proved in the whole technical activity of industrial nations. As examples are discussed gradation of sizes, and of raw materials, tools, gauges, motors, pumps, etc., and further, diameters, lengths, revolutions, feed, gear-teeth, pitches, etc. To settle types on all spheres of human activity is always economical if this " typing " is based on standard figures.

SURFACE TREATMENT.

Dauerfestigkeit hartverchromter Teile. (*Continuous resistance of hard-chromed pieces*), by H. Wiegand and R. Scheinost. (*VDI-Zeitschrift Vol. 83, No. 21, May 27, 1939, p. 655, figs. 13*).

Hard coatings of chromium are often used to-day as a result of the good intensity of retention of the chromium layer, good resistance against corrosion, great hardness and resistance to wear. In particular, objects which are strained by wear—*e.g.*, gauges, are chromed. The unfavourable influence, however, of the hydrogen on the durability—*e.g*, of the different kinds of steels, must not be neglected. This influence is not investigated in the article. Samples of continuously loaded bars of chromium-steel, chromium-molybdenum-vanadium steel, hard and mild ordinary steels are tested which were correctly and faultily chromed.

Descaling Steel by Flame Process. (*The Engineer, Vol. CLXVII, No. 4352 June 9, 1939, p. 720, figs. 4*).

The cleaning and dehydrating of structural steel by the oxy-acetylene flame. The technique is sufficiently analogous to familiar welding and cutting operations with oxy-acetylene torches, so that any competent operator in this field is equipped to instal and operate the flame method of descaling. Action of descaling flames. The high temperature flames result in a differential expansion, causing the scale to lift and fly off as shown. Where, because of insufficient number of heated shapes, the use of a fitted tip assembly is not warranted, a flexible tube assembly may be used. The closed formation of this flexible assembly of six-tube, five-flame tips permits concentration of the flames. An assembly of multi-flame flat tips on hard-faced skids may be employed where scale conditions permit. Flame descaling billets with a flat tip assembly mounted vertically on a carriage for descaling a single surface in one pass.

WELDING, BRAZING.

Le Chalumeau et ses Principales Applications. (*The blow-pipe burner and its main applications*), by W. Bonhomme. (*Bulletin mensuel Société Royale Belge des Ingénieurs et des Industriels, No. 4, 1939, p. 320, figs. 22*).

Part II.—Oxy-cutting as operation of thermal treatment. Practical cuttin with fusing burner. Sectional drawings. Fusing burner acting under water. Automatic cutting machine with magnetic guide. The principal factors of cutting are : (1) Power of burner. (2) Pressure of cutting oxygen. (3) Cutting speed. (4) Coefficient of apparatus. Prime costs of gas cutting. Cutting under water ; cutting of cast iron. The triple burner. Part III. (Methods of hardening the surface of metals).—I *Chemical procedures* : (a) With melting the metal ; (b) without melting the metal. II. *Physical procedures* ; (a) " Classic " tempering ; (b) superficial hardening by blow-pipe burner. Surface converting (homogeneous and heterogeneous) : (1) By carbon steel with the burner. (2) By special steel. Hatfield's manganese

steels (10 to 17% Mn, 1 to .4% C, P = O. 1%). (3) Surface converting by special alloys : stellite, Hay-stellite. IIb. Surface hardening by using the blow-pipe burner : (A) Depth of hardened scale : (1) Speed of heating action. (2) Shape of piece. (B) Superficial hardness : (1) Temperature of surface. (2) Speed of cooling. (3) Composition of steels. Advantage of surface hardness. Description of some hardening machines : for gear teeth, for cylindrical and plain surfaces.

Spot Welded Joints: Data and Procedure for their Design in Various Metals —I, by L. H. Frost. (*The Machinist, Vol. 83, No. 17, June 3, 1939, p. 254E, figs. 7*).

Spot welding mild steel. Welding stainless steel Welding high-carbon steel. Tables on electrical resistance of various metals Graphs : Spot spacing, spot (electrode) diameter, maximum strength, all in relation to stock thickness. Welding transformer input, total electrode pressure.

A Survey of the Field of Spot Welding, by C. W. Leng, A.M.I.P.E., F.R.S.A (*Sheet Metal Industries, Vol. 13, No. 146, June, 1939, p. 798, figs. 4*).

A Paper presented at the London Section of the Institution of Production Engineers. The basis principles are deeply rooted in the physical structure of matter and the manner in which that structure is affected by the passage of a very large electric current in a very short period of time, whilst it is being gripped under a very high pressure. The surfaces are variable whose nature has been determined by a number of circumstances : (1) The nature of the material itself. (2) The method by which that material was produced (either hot or cold working, pickling, annealing, etc.). (3) The substances with which it has come in contact since its manufacture (atmosphere, moisture, chemicals, abrasives, knocks and blows, etc.) (4) The length of time it has been exposed to these conditions. Characteristics : (1) Electrical conductivity. (2) Specific heat. (3) Density. (4) Welding temperature. (5) Thermal conductivity. Detailed information is given to each single item.

The Application of Resistance Welding to Small Parts, by Paul G. Weiller. (*The Welding Industry, Vol. 7, No. 5, June, 1939, p. 183, figs. 5*).

Resistance welding is, as a matter of course, as well suited to the fabrication of small objects as to the heaviest work. Extensive use of spot welding in the manufacture of radio valves and similar devices amply bears this out. A large proportion of small objects are of odd shapes and made of non ferrous metals or special iron alloys which require great care in tooling and setting up at the work for best results. What metals can be spot welded ? What to look out for when welding small parts. Some practical applications of spot welding to small parts. Welding typewriter ribbon spools. Assembly of table knives.

Welding in Chemical Engineering. (*Engineering, Vol. CXLVII, No. 3831, June 16, 1939, p. 705, figs. 8*).

Welding is of particular service to the designer of chemical plant as it enables him to obtain the exact shape required to carry out a chemical process most advantageously. A second point of particular value in the industry is that the interior of vessels can be made with an unbroken surface. The units

of a welded chemical plant can, moreover, be economically made larger than before with attendant increase of output. Vessels capable of withstanding pressures of 600 lb. per sq. in. or more can be constructed. Three different methods—viz., gas welding, electric resistance butt welding and metallicarc fusion welding. Gas welding may be done with either the oxy-acetylene or oxy-hydrogen flame. Gas-welding for vessels of comparatively thin plate and which are to contain no corrosive liquors has proved very successful. Electric resistance butt welding is specially suitable for welding tubular parts, such as tubular heaters, and has the advantage that no other metal than the parent metal is employed. Photomicrographs indicate clearly the desirability of heat-treatment, after this type of welding and show that the weld is, after treatment, wholly satisfactory. Tests of flash-welded tubes. Metallic arc fusion welding is probably used more than any other method for the fabrication of chemical plant in both iron and steel. The success of the welding operation depends to a great extent on the characteristics of the electrode. Tests of coated and non-coated electrodes In most cases the best results with metallic-coated electrodes are obtained by adjusting the arc length so that the tip is just above the pool and not in actual contact with it. The Unionmelt welding process, in which an automatic welding head is employed for feeding a bare rod and controlling the welding conditions. The process uses a "melt" of a mineral nature for the protection of the molten weld metal. Tanks are welded of mild steel and are unlined, from 15 ft. in diameter to 60 ft. in diameter by 30 ft. deep. Stainless steels may be welded either by gas or by electrical methods. To obtain the correct flame condition excess acetylene is first supplied and then slowly reduced until the inner cone of the flame shows the faintest tinge of white. In the arc-welding of stainless steel, the arc should be kept as short as possible. Resistance welding may be applied to stainless steels either as butt, spot, or seam welding. In fabricating pressure vessels by welding, it is advantageous to attach test pieces to the vessel under construction. The test pieces are subject to the same conditions regarding heat treatment and processing as the vessel itself. The chemical industry is a large user of plant constructed of non-ferrous metals; for example, copper stills for alcohol distillation, copper jacketed pans and autoclaves in the pharmaceutical trades, aluminium tanks for edible products, nickel and its alloys for synthetic resins and other corrosive materials. Small parts of chemical plant may usefully be made of tantalum. Its melting point is over 2,800°C. Hard carbon electrodes of small diameter are generally used and, when the sheets of tantalum are thin a relatively low welding current must be employed in order to localise the heat. The welding of all joints of complete systems of pipes, including those of valves, cocks, and branches, is now being practised in some chemical works.

Cost of New Crankshaft Saved by Electric Welding. (*Electric Welding, Vol. 8, No. 46, April, 1939, p. 110, figs. 6*).

The crankshaft which was 7 in. diameter and of the three-throw type was directly coupled to an electric motor. The shaft was fractured from the base of the keyway to a distance of one-third of the circumference of the shaft 7 in. along the keyway with a depth of a maximum of 1 in. The plant has been in service now for over twelve months and the repair to shaft has proved entirely satisfactory, being subjected to periodical Government inspections, The repair was completed in under three weeks.

Saving 5,000 Tons of Steel by Welding. (*Electric Welding, Vol. 8, No. 45 April, 1939, p. 105*).

Since 1931 the German shipbuilders, Blohm and Voss, have economised in steel in the construction of ships to the extent of **5,000** tons by the employ-

ment of electric welding. In a 24,000-ton motor-passenger liner, the saving amounted to some 1,300 tons, or about 14% of the total weight of the hull, and there was, moreover, an economy in rivets to the number of 1,600,000. A reduction of 126 tons of steel was effected in the bulkheads and tanks, whilst the deck welding effected a saving of 177 tons. The amount of steel used in the deckhouses was 120 tons less than it would have been with normal riveting. The greatest advantage of the employment of electric welding in shipbuilding is to be found in the construction of tankers, and that in a vessel of 15,000 tons deadweight capacity an economy of 17% in weight of steel could be effected.

Recent Welding Developments in the U.S.A., by R. M. Gooderham. (*The Welding Industry, Vol. 7, No. 5, June, 1939, p. 164, figs. 10*).

Survey of the progress of welding in the United States of America during the past few months. The various fields of application are briefly dealt with and an indication given of the trend of future developments. High labour costs. Manipulators. Production methods in the motor car industry. Copper and aluminium. Hard surfacing and repair. Appearance of welds. Welding promoted by executives. Testing welds. Shipbuilding. Structural welding. Design symbols and technique. Oil industry. Electric preheating and annealing. Railways. Machinery fabrication. Education. The most important recent movement is probably the serious consideration being given to uniform training and qualifying tests for inspectors of welding.

TECHNICAL INFORMATION.

Value of British Machine Tool Production, 1935. (*The Machinist, Vol. 83, No. 18, June 10, 1939, p. 263 E*).

A census was last taken in connection with the year 1935, and the final report has now been issued. In machine tool establishments some 21,082 persons were employed, the gross output being £8,272,000 and the net output £5,577,000, or an average per person of £265 per year net. More than one-third of these establishments employed less than 50 persons, and more than half less than 100. On the other hand, seven establishments employed 750 persons or more, the total here being 8,691, or approaching 1,250 on the average. The largest net output per person, namely, £299, is shown for these seven establishments, the lowest figure, £220, applying to 31 businesses employing between 25 and 50 persons. Tools valued at £2,246,000 were exported, or, say, one third of the total, while in the same period imports were valued at about £1,698,000. The total exports of British machine tools during April, 1939, were : 2,711 tons = £399,190. The total imports were : 2,556 tons = £458,719, of which there came from U.S.A. 921 tons = £222,667, Germany 873 tons = £124,731, France 308 tons = £11,973.

Die Werkzeugmaschine (*The machine tool*), by K. Hegner. (*VDI—Zeitschrif, Vol. 83, No. 25, June 27, 1939, p. 747, figs. 21*).

The interesting part of the article is the final chapter on the economic importance of the German machine tool industry. Total output 1938 was 650,000,000 RM (£52,000,000), 160,000,000 (£12,800,000), of which were exported (about 25%). The total number of employees of about 500 works was 90,000. There are only a few great works with above 1,000 operators ; most are small (50 to 150 operators), and medium-sized (up to 400) factories. The author stresses the need for professional workers and for the education of a sufficient number of good apprentices. The machine tool works have formed

a great portion of all the German skilled workers who now work in other mechanical branches. These skilled craftsmen ought to be given back to their mother industry.

Machine Tool Notes from Abroad. (*Machinery, Vol. 54, No. 1393, June 22, 1939, p. 396*).

Germany. Imports of machine tools in April totalled 148.8 tons, valued at 548,000 RM. (£46,800), compared with 325.4 tons, valued at 1,141,000 RM. (£97,500) in March. Exports in April totalled 7,442.5 tons valued at 17,253,000 RM. (£1,474,700), compared with 10,536.5 tons, valued at 20,844,000 RM. (£1,857,700) in March.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING.

The Heat Treatment of Non-Ferrous Metals and Alloys, by W. B. Barker. (*The Australasian Engineer, May 8, 1939, Vol. 39, No. 276, p. 15*).

The main object is to restore to the material its original ductility which has been destroyed by the application of work of some description. Annealing. Definition of the term "metal and alloy." Restriction to copper, bronzes and brasses. Arsenical copper rods. Effect of annealing temperature on physical properties. Precipitation hardening of 2.15% beryllium copper alloy sheet. Effect of pouring temperature. Effect of heat treatment on the strength of Admiralty gun metal. Standard treatment for optimum properties. Effect of heat treatment on physical properties of aluminium bronze rods. Heat treatment of manganese bronze.

ACCOUNTING, ADMINISTRATION.

Works Orders Control, by H. A. Simpson, F.C.W.A. (*The Factory Manager, July, 1939, Vol. VII, No. 7, page 373*).

In a large plant quite an appreciable amount of work is executed under the heading of "Repairs" which is not strictly repair work; some of it is experimental, some change of design and some of it is small capital expenditure work. This work can be classified into: (*a*) Capital Special Expenditure, (*b*) Revenue Special Expenditure (both of these are authorised by a "special expense order"), (*c*) Change of Design (not authorised by special expense order—this class covers alteration in design of existing plant and machinery), (*d*) Manufacture of Spare Parts. Any capital or revenue expense which is estimated to cost over £50 must be requested on a special expense card. Numbering of works orders. Issue, progress and planning of the works orders

When New Equipment Pays, by J. C. Wattieworth and G. V. Patrick (*The Machinist, July 15, 1939, Vol. 83, No. 23, p. 440*).

Two charts are used in surveying the economics of machine replacement. Chart I is a calculation form designed to facilitate the calculation of production increase to be expected from replacement of existing equipment by new machine tools. Chart II is a nomographic diagram for the calculation of investment return and profit: (*a*) When equipment is fully depreciated; (*b*) when equipment is incompletely depreciated.

COOLANT, LUBRICANT.

Neuerungen bei selbsttaetig wirkenden Schmiereinrichtungen (*Recent Changes of Automatic Lubricators*), by C. Baum. (*Stahl und Eisen, July 6, 1939, Vol. 59, No. 27, p. 791, figs. 30*).

Progress during recent years. Detailed review of new apparatus; simple oils and greases. Oilers and greases operated by pressure. The apparatus has a very great security of service and can furnish oil against every usual working pressure.

Die Messung zaeher Oele (*Measuring Viscous Oils*), by Kurt Zillmer. (*Siemens-Zeisschrift, June, 1939, Vol. 19, No. 6, p. 278, figs. 11*).

A systematic survey is indispensable. Dependence of the viscosity of oils on the temperature. Method of measuring. Range of application. Measuring great quantities. Measuring small quantities in garages, etc. Design of apparatus. Oilcounter of Siemens. Scheme and details of oil-drawing plants.

ELECTRICAL ENGINEERING.

Drehzahlreigelung mit gittergesteuerten Stromrichtern (*Regulating the Number of Revolutions by Grid-Controlled Rectifier*), by W. Nowag. (*VDI-Zeitschrift, July 15, 1939, Vol. 83, No. 28, p. 827, figs. 16*).

Competition to and replacement of the Leonard Drive by the Grid-Controlled Rectifier. The rectifier is more economical, especially for great output. Qualities of the grid-controlled rectifier. Possibilities of regulation. Transformation of direct into alternate current. Regulating rectifier. Variation and reversing of voltage. Reversing of current. Motor driven rectifier. Advantages and disadvantages of the rectifier for variable speed drives. Static transformation; instantaneous regulation. Peaks of power to the mains. Fall of power factor. Methods of operation of variable speed drives. Motor and rectifier built together. Range of application: rolling mills, colliery winder, colliery haulage. Ventilator and propeller drives. Waterworks with variable delivery. Lignite and brickett factories. Textile and rubber industries. In smaller degree for machine-tools: large grinding and planing machines. Paper-cement-sugar industries.

Electrolytic Condensers, by Philip R. Coursey, B.Sc., and S. N. Ray, M.Sc., B.Sc. (*The Journal of the Institution of Electrical Engineers, July, 1939, Vol. 85, No. 511, p. 107, figs. 21*).

The paper deals with the development of the electrolytic condenser which is now so widely used in modern radio receivers and in amplifying apparatus. A brief historical survey is given to indicate the lines of development which have led up to the modern designs. This is followed by descriptions of the construction and chief electrical properties of the various types of condensers

which are now used. These properties influence to a very great extent the manner in which the condenser can most economically and usefully be employed. The manufacturing methods are treated at some length, together with the considerations which influence the employment of these condensers in various practical applications. A standardised method of test is recommended to secure uniformity in assessing their properties.

HEATING, VENTILATION.

Where Hot Air Helps, by Edward Stephenson, Jr. (*The Machinist, July 15, 1939, Vol. 83, No. 23, p. 433*).

Movement of large volumes of heated gases around objects in the convection furnace results in rapid and uniform heat transfer. Furnace structures. Linings. Conveyors, Heaters. Burner equipment. Fans. Temperature control. Safety control. Flow of air within a small batch-type convection furnace. A removable basket holds the parts being heated. Duct systems. The fundamental principle of natural convection is that heated air rises and cold air falls. Therefore the return ducts should be from the bottom of the furnace.

GEARING.

Why Gear Teeth Wear, by T. R. Rideout. (*The Machinist, July 15, 1939, Vol. 83, No. 23, p. 425*).

Gear tooth failures are of two common sorts: breakage and excessive wear. Industrial gears seldom fail by breakage, and when they do the nature of the fracture or the attendant circumstances usually disclose the cause. The wear, in order to constitute failure, must be premature, rapid and excessive. Kinds and causes of wear: (1) Incorrect design or application. (2) Defective workmanship or material. (3) Service or operating conditions. (*a*) Overloading. (b) Lack of lubrication. (*c*) Presence of foreign matter, such as abrasives, dirt or particles. (*d*) Improper mounting. Normal wear. Pitting. Corrective or so-called incipient pitting. Destructive Abrasion. Spalling. Scoring and galling. Scuffing, wiping, cutting. Rolling or peening. Pitting is the most common kind of gear tooth wear, and scoring or galling the most serious kind. It is relatively easy to distinguish between any of the kinds of wear, but the nature and degree of any one type may vary.

MACHINE COMPOUNDS.

An Investigation of the Warlop Bush, by D. Clayton, B.Sc., and M. J. Wilkie, B.Sc. (*The Engineer, June 23, 1939, Vol. CL × VII, No. 4354, page 761, figs. 5*).

The Warlop bush described was a liner to the usual bush, and it was pierced radially by a series of holes, which were joined by circumferential and axial or helical channels cut in the outside surface of the liner. It was claimed that the holes and channels allowed lubricant to return through them from regions

of higher pressure to regions of lower pressure, thus avoiding "return currents" within the clearance space itself, and consequently allowing the film to form more easily on starting, and reducing the viscous friction during running. *Normal running tests:* The tests were carried out with loads of 60 lb. and 200 lb. per square inch, and at speeds of 300 and 1,500 r.p.m. Typical friction-temperature curves are shown. The running with the Warlop bush was not steady, as in the case of the plain bush. The friction fluctuated, and the reading recorded on each occasion was an estimated mean value. *Heating tests. Decreasing speed tests.* This is a practical test of direct interest for applications of the bush to mechanisms running at low speeds and having to start and stop frequently. *Tests with an experimental bush.* A bush was made with only eight small holes; these holes were thought to reduce the surface of the bush little, and yet provide the means for some oil circulation according to the suggested principle. These tests showed that while the bush with fewer holes was much better than the one with many holes as supplied, and approached the plain bush in its characteristics, it was, nevertheless, inferior to the plain bush in each respect. Conclusion: Over the range of conditions of the tests the coefficient of friction of the Warlop bush is greater than that of a plain bush. Also, the limit to fluid-film lubrication is reached earlier with the Warlop bush as the speed is decreased. The behaviour is better when there are fewer holes and connecting channels, but it is still inferior to that of a plain bush.

MACHINING METALS.

Diamant Hartmetall fuer Schleifzwecke (*Diamantided hardmetal for grinding purposes*), by W. Dawihl and A. Fehse. (*Maschinenbau, July, 1939, Vol. 18, No. 13-14, p. 349, figs. 3*).

The most favourable shape of application of diamond tools in machining etals. The best execution at present. Diamond grits agglutinated by cemented carbides. Cemented carbides bind better than iron or steel, because of uniform dilatation with diamond material. Loosening of diamond grains essentially smaller than with any other binding. The grains are better soaked. The cemented carbide does not become plastic by heat and does not glaze the grains. There is no disposition to flow. Size of diamond grains=0.15 to 1 mm. (0.006 in. to 0.04 in.) for roughing cuts and down to 0.06 mm. (0.0025 in.) for finishing. Examples of executed tools. Maintenance. Range of application. Regrinding of profiled cutter of cemented carbide. Relieving of the teeth of a bore crown.

Grinding Allowances, by "Trois." (*Machinery, July 13, 1939, Vol. 54, No. 1396, page 472*).

The allowances required to permit of a surface being cleaned up by grinding vary with the section of the part, the material, the skill of the hardener, the condition of the machines used for previous operations, and other factors. Distortion during heat-treatment. Quality of turned finish. Method of dimensioning turned surfaces. The turning allowances must be carefully considered to ensure that all surfaces will clean-up during grinding.

Handling Milling Jobs. (*Machinery Lloyd, July 1., 1939, Vol. XI, No. 13, page 21, figs. 15*).

Chart for an approximate calculation of the power required for milling machines. If the "average chip section" is known, the "specific cutting pressure" in 1,000 lbs. sq. in. can be immediately read along the corresponding vertical line. Rate of cutting. Roughing cuts. Finishing cuts. Cutting speeds. Selecting the right type of machine. Diagrams showing the manner of measuring the apparent rake and clearance angles at the side of the cutter, and how they must be converted in order to obtain the true values. Selection of the right milling cutter. The proper cutting angle. The best method for clamping cutters. Correct design and clamping of the workpiece.

Die Design and Construction. (*Machinery, July 13, 1939, Vol. 54, No. 1396, p. 469, figs. 7*).

General arrangement of a compound type of blanking and piercing die. Drawings illustrating features of die-button design. Methods used for preventing die buttons from turning. Chute for shedding slugs from pierced holes. Shedding slugs through holes in the adapter, the shoe and the bolster plate. Slug channel cored in the bottom surface of the lower shoe, provided for shedding slugs. Arrangement of die-button backing plates.

Simple Bending Dies, by C. W. Hinman. (*The Machinist, July 15, 1939, Vol. 83, No. 23, p. 436, figs. 13*).

Bend location and accuracy are dependent on the type of die chosen—V benders for ordinary parts, and spring-pad tools for precision work. Movements in the work material follow the paths of least resistance. For many pieces it is unnecessary to work out the die form in the die block, because the work follows the punch contour. Spring-back prevents a true 90° bend. With the punch modified, spring-back is overcome. A convex bottom on the channel throws the sides into true. Side-creep of the blank is prevented by a knurl-faced spring pin. By relieving the sides of the punch the same tool can be made to serve for several bends. Methods for making accurate bends.

Ziehwerkzeuge für das spanlose Formen von Leichtmetallen (*Drawing Dies for the Plastic Forming of Light Metals*), by E. I. Ritter. (*Maschinenbau, July, 1939, Vol. 18, No. 13/14, p. 335, figs. 15*).

The influence of the production of aeroplanes of light metals on the development of drawing dies made of steel, cast-iron, electron. Pushing-through tools. Combined drawing dies. Drawing dies made of wood. Dies of hard wood and hard fabric. Drawing action with rubber tools. Heated dies to draw electron sheets. Tables on the constituents of raw materials. Manufacture and cost of the tools.

Machining Operations on Anti-aircraft Shells. (*Machinery, July 6, 1939, Vol. 54, No. 1395, p. 429, figs. 11*).

Machining Operations on the 8.7 in. Shell Body. (*Machinery, June 29, 1939 Vol. 54, No. 1394, p. 401, figs. 23*).

The form of the forging, turned, ready for the bottling operation. Section through the bottling die. Section through the nose of the shell showing the work done on the preceding machine. Maxicut lathe arranged for finish-turning. Form tool for the operation of turning the copper band. Stages in the manufacture of the shell body at another factory and the necessary machine tools.

Shell Production on Hydraulically Operated Machines. (*Machinery, July 15, 1939, Vol. 54, No. 1396, p. 461, figs 15*).

Diagram showing the hydraulic system for operation of shell lathes. Diagrams showing the rough forging and the work done during the turning operations. The Littlejohn Philip "A" type machine. Diagrams showing work done in the bore. Diagrams indicating the work done at the fuse end of the shell after bottling. Diagrams indicating work done on the base end of the shell.

The Manufacture of Shell Forgings by the Extrusion Process. (*Machinery, July 6, 1939, Vol. 54, No. 1395, figs. 9*).

Diagrams showing the method of producing shell forgings by the extrusion process. Diagrammatic arrangement of the tools used on the press.

Exhaust Manifolds for In-Line Engines, by Maurice A. Smith. (*Aircraft Production, July, 1939, Vol. I, No. 9, p. 313, figs. 12*).

Rolls-Royce, Ltd., of Derby, have done a great deal of development work on manifolds for in-line-type engines. Their present designs and the stages in the manufacture from Inconel nickel alloy are described in this article.

Anson Production, by S. W. Hiscocks. (*Aircraft Production, July, 1939, Vol. I, No. 9, p. 303, figs. 27*).

The wood mill : glueing main wing spars : welding the fuselage and engine nacelles : final assembly at Woodford.

Flush Riveting, by Don. R. Berlin. (*Aircraft Production, July, 1939, Vol. I, No. 9, p. 299, figs. 12*).

The Curtiss Aeroplane Division initiated a flush riveting development project in connection with the production and tooling of a large number of

aircraft under construction. The programme was laid out under the following heads : (1) Consideration of elements common to brazier and flush riveting. (2) Investigating types of flush rivets. (3) Experimental development and tooling. (4) Test methods. (5) Development of production tools and procedure. (6) Scrutiny of actual production to study possible improvements. (7) Microphotographs of actual production riveting. (8) Checking production costs. (9) Summary and recommendations. Tables and illustrations show the execution of this wide programme.

Möglichkeiten der Leistungssteigerung in Stahlwerksbetrieben (*Possibilities of Output Increase in Steel Mills*), by Bulle. (*Stahl und Eisen, July 13, 1939, Vol. 59, No. 28, p. 809, figs. 4*).

German practice : possibilities of enlargement of Thomas (basic steel) mills. Concentration of oxygen of the blast or its preheating. Reduction of the finishing time and repair time. The Thomas (basic steel) process is the most effective steel-producing method in Germany. Increase of output of the Siemens-Martin process. Thomas-Electro-Duplex process. Selection of the best suitable procedure.

MATERIALS; MATERIAL TESTING.

The Effect of Melting Conditions on Light Alloys, by A. J. Murphy, S.A.E. Wells and R. J. M. Payne. (*The Aluminium and Non-Ferrous Review, June, 1939, Vol. 4, No. 7, p. 215, figs. 4*).

The conditions prevailing during melting in the production of aluminium and magnesium alloy castings of high quality. (*a*) Contamination. (i) Aluminium alloys. (ii) Magnesium alloys. (*b*) Change in composition. Effect of temperature attained by the molten metal. Aluminium alloys. Benefits of fine grain. When considering the mechanical properties of actual castings, the most important effect of grain refinement is not in conferring high values of strength, but in the greater consistency of properties in the different parts and varying sections. The most easily applied method is that of incorporating in the alloy an element which by its presence produces a small size of micrograin. Niobium (or columbium) and titanium stand out as the most effective in their grain-refining action. For most aluminium alloys suitable conditions for this test are obtained by pouring the metal at a temperature of 800°C. into a dry-sand mould.

Rolled Inconel Sheet (*Sheet Metal Industries, July, 1939, Vol. 13, No. 147, p. 871, figs. 3*).

Inconel is a corrosion-resisting alloy containing approximately 80% nickel, 12 to 14% chromium, balance mainly iron. Nickel contributes in high degree to its resistance to corrosion by a great many inorganic and organic compounds throughout a wide range of acidity and alkalinity. Chromium confers the ability to remain bright under exposure to sulphur compounds in the atmosphere or in other corrosives; it also provides resistance to oxidising atmospheres at elevated temperatures and to oxidising conditions in corrosive solutions.

Rubber versus Neoprene Belting. (*Neoprene News, No. 5, p. 5*).

TABLE OF COMPARISON

Immersed in	Temperature	Rubber period of immersion required to perish the sample	Neoprene period of immersion required to perish the sample.
Water	212°F.	28 days	182 days
Hydrochloric acid (conc.)	158°F.	3 days	182 days
Sulphuric acid (diluted with an equal volume of water)	158°F.	3 days	56 days
Mineral oil ...	158°F.	25 days	More than 400 days

Tough jobs for belting : (1) Belts in dust and steam. (2) In an acid atmosphere. (3) In hot acid fumes. (4) The belt was oiled. (5) Hot acids—a bad case. Neoprene for round drives. The limit for rubber. Conveyor belts.

MEASURING METHODS.

Betriebs-und Festigkeitskontrollen durch lichtelektrischeSteuerungen (*Control of Service and of Production by Photocell Governing*), by A. Ott. (*Maschinenbau, July, 1939, Vol. 18, No. 13/14, p. 341, figs. 6.*

Application of photocell steering to different technical branches. Counter-apparatus. Drive governor. Control of the height of the fluids in reservoirs. Separation by accuracy of dimension. Examination of thickness variation and irregularities of surface. Checking tightness of tubes. Arranging and disentangling pieces for packings, *e.g.*, printing on cigarettes, on boxes, heads of matches, bolts, etc. The optical contrast process.

The Vectorscope, by George J. Dashefsky. (*Transactions of the A.S.M.E., July, 1939, p. 403, figs. 16*).

The machine consists of a disc mounted in gimbals in the manner of a nautical compass, on which are placed weights representing the vectors to be added. A spot of light on the screen indicates directly the resultant vector and its direction, as well as its horizontal and vertical components. The mathematical principle is developed, and the instrument is shown to be suitable for studying crankshaft arrangements with respect to unbalanced moments and torsional vibration. The suitability of any firing order for any crankshaft configuration may be ascertained simply and quickly. It is shown that the instrument is inherently adapted to making harmonic analyses of periodic functions and the theory of this application is discussed. Results by this method of analysis compare favourably with other methods.

Oberflachenprüfung von Flachen mit hohem Gütegrad (*Surface Testing of High Quality Surfaces*), by W. Dreyhaupt. (*Werkstattstechnik und Werksleiter, July 1, 1939, Vol. XXXIII, No. 13, p. 21, figs. 20*).

The quality of a surface is to be proved according to the demands of the use. There are two groups: (1) surfaces of parts, the finish of which is of importance and not the geometric form. (2) Surfaces, the geometric form of which is essential, *i.e.*, the wearing portions of which must be as great as possible. To measure these surfaces with workshop instruments a magnification of 74 : 1 is limited to 2 micron (0.002 mm.=0,0001 in). Diagrams of shop measurements. The quality of the surface of a journal is determined by the stress which it can sustain. The load is not uniformly supported by the total surface of the bearing, but mainly by those spots which by the mediation of the oilfilm touch the opposite portion of the bearing. These places are interrupted by scratches produced by machining, i.e., by grinding. Essential regarding a bearing are the elevated spots and not the valleys which, however, keep the oil. In checking the wearing spots, the real supporting surface is to be measured. The principle of Mechau of the partly total reflection. The more the total reflection is disturbed, the better is the surface. Using a microscope to check the place of contact, it will be easily detected how many spots of the surface are contiguous to the glass-prism, *i.e.*, belong to the wearing surface. The checking itself is done by measuring linearly the produced image in a vertical plane to the grinding scratches. The extent is given by marks in the eyepieces. Diagrams of the new method are compared with the known procedure of light-section. The described method is in particular used to check the exterior surface of shafts. Another instrument was designed to prove bores. The supporting percentage of first-class slip gauges is 0.9, very well lapped surfaces have 0.7, very fine ground pieces 0.4, exceptionally well ground pieces 0.5, fine ground pieces 0.3, and standard ground pieces 0.2. The author publishes a table of gradations which he is recommending as standard units. The standardisation is only possible if the force is known by which the measuring instrument is pressed to the surface to be checked. It is recommended that the pressing forces be adapted according to the diameter.

Ein neuer Kleinharteprüfer zur Bestimmung der Harte dünnster Schichten mitder Diamantpyramide (*A new small tester for hardness to indicate the hardness of thinnest layers with the diamond pryamid*), by P. M. Dohner. (*Werkstattstechnik und Werksleiter, July 15, 1939, Vol. XXXIII, No. 14, p. 357, figs. 8*).

In consequence of the independence of the Vicker's hardness from the testing load this latter method is specially qualified for the testing of thin layers. The usual machines are not suitable for testing loads of less than one kg. (2.2 lb.). Therefore, the testing of thin layers was limited to about 0.14 to 0.06 mm. according to the hardness. The largely spread demand to test numerically, in particular thin layers with nickel plated, chromed, or coppered pieces as well as the quality of the nitrided hardness, led to the design of the small tester for hardness described hereafter.

A Vicker's diamond in a box can be charged with the following range of loads—50, 100, 150, 200, 250, 300, 350, 400, 450, 500 grammes (approximately 2, 4, 6, 8, etc., ounces). To measure the indentation the microscope is furnished with a micrometer eyepiece, with which it is possible to measure the size of the indentation to a fraction of a micron (=0.001 mm.=0.00004 in.). The best magnification has proved to be that up to 200....300 fold. The samples chosen for testing must, of course, have a smoother surface. The unity of measure is, as with the Vicker's method, the diagonal of the indentation. From this the value of hardness is derived. The accuracy is approximately proportional to the magnification of the microscope only up to 50 times.

Messung des Werkzeugverschleisses beim Zerspanen dünner Werkstoffstangen (*Measuring the wear of cutting tools in machining bars of small diameter*), by Heinrich Schallbroch and Wilfried Ulbricht. (*Werkstattstechnik und Werksleiter, July 15, 1939, Vol. XXXIII, No. 14, p. 345*).

"Machinability" combines cutting force, surface quality, shape of chips, and life of tool, the knowledge of which is necessary to answer all questions of the cutting departments. The investigation of the time of life was always the most important part of machinability tests. With some kinds of cuttings, however, the life is not finished by melting away the cutting edge, but by its increasing wear. The moment of destruction is reached when its cutting capacity is diminished in such a way that it must be reground. Examples: (1) Machining of light metals with high-speed and cemented carbide tools. (2) Machining of steel with cemented carbides. (3) All cutting actions on the automats, if great precision and long life are more important than a great number of pieces in the unity of time.

The authors indicate that cutting speed which creates by lengthwise turning at the cutting edge in 60 min. time a wear-mark of 0.1 mm. (0.004 in.) as width with V 60-0.1. Another method is to check the wear of the cutting tool by plunging and not by lengthwise turning; it has been proposed by H. Schaumann. He applies his method to (*a*) bars for automatics, (*b*) light metals on automatics, deriving thus the machinability of screw-machine bars. The unity of wear of the tool, together with accuracy of dimensions and surface finish, is measured by the plunge cutting test. The various results of the new method are given in testing some screw-machine steels and light metals.

MATHEMATICS, MECHANICS.

Zur Berechnung von Walzenständern (*Calculation of uprights of rolling mills*), by P. Gruener. (*Stahl und Eisen, July 20, 1939, Vol. 59, No. 29, p. 833, figs. 15*).

Enquiry into the actual progress of the stresses, forces and deflecting moments of the different portions of the frame of a rolling mill by calculation and graphic methods. Consideration of the variation of the moments of inertia in drawing the graph of moments, caused by variations of section of the stand. Approach of the neutral layer to the drawn fibre. Graphs of the course of stresses in closed and open rolling-mill stands. Conclusion for the design of new stands.

POWER, DRIVE.

Atomisation of Oil by Small Pressure Atomising Nozzles, by E. B. Glendenning, A. R. Black, L. H. Ventres and W. A. Sullivan. (*Transactions of the A.S.M.E., July, 1939, p. 373, figs. 12*).

This paper develops the importance of atomization, carburation, and oil characteristics for efficient combustion, and demonstrates the effect of pump pressure, oil viscosity, variation in oil temperature, and nozzle design on the rate of efflux and spray characteristics. It includes a study of hollow- and centre-spray nozzles with relation to oil viscosity, aerodynamic design of the oil burner, and combustion efficiency.

PSYCHOLOGICAL INVESTIGATION.

The Use of Tests in Vocational Guidance, by Alec Rodger. (*Occupational Psychology, July, 1939, Vol. XIII, No. 3, p. 200*).

People want to know : (1) to what extent testing can be held to supersede other methods of studying young people who seek advice ; (2) by whom tests should be used ; (3) what relevance " factor " theory has to vocational guidance testing ; (4) what vocational psychologists have to say about the validity and reliability of their tests.

Selecting Personnel for the Swedish State Railways with the Aid of Psychological Tests, by Rudolf Anderberg. (*Occupational Psychology, July, 1939, Vol. XIII, No. 3, p. 211*).

The purpose of the tests was not to establish a rank order of applicants, but to assist in eliminating those that were clearly unsuitable. The rules of admission and training of male employees of the State Railway. (1) Intelligence tests. (2) Reaction test. (3) Attention test. (4) Memory test. Validation of the tests by comparison with employees' ratings. Detailed results of the comparison.

Industrial Relations in the United States, by Dwight L. Palmer. (*Occupational Psychology, July, 1939, Vol. XIII, No. 3, p. 178*).

Dr. Dwight Palmer discusses in some detail important aspects of American industrial relations. He refers particularly to the apparent conflict between actual industrial practice and the individualist principles erroneously supposed to underlie it. In this connexion he emphasizes the important position of day-to-day workers within the field of industrial relations. Brief outline of recent American industrial history. The economic creed of individualism. Significance of the contrast between individualistic principles and actual industrial practice. Implications of the individualistic theory. Drift to " pseudo-humanism." Drawbacks of both positions. Recent events in the light of this interpretation. Likelihood of period of frustration. Significant position of industrial relations. Encouraging aspects of American culture. Potential danger-points. First the growing American tendency to place increased reliance on activities at Washington. The demand for a thirty-hour week. Second, the increasing " depersonalisation " of the human contacts of the American factory system. Compensation by the " human capacity to collaborate." Trade Union problems.

Rest Pauses and Refreshments in Industry, by J. Ramsay, R. E. Rawson, and others. (*The National Institute of Industrial Psychology, Report 8, 1939*).

The National Institute of Industrial Psychology has issued a report of unusual interest on the subject of rest pauses and refreshments in factories. The results are based on information obtained by means of personal interviews with responsible officials in 1,050 factories, employing about 305,000 workpeople. Equal numbers of factories were visited in seven industrial areas of Great Britain—London, Cardiff, Birmingham, Manchester, Leeds, Newcastle-upon-Tyne and Glasgow. A wide variety of industries was included, though such non-factory activities as mining, building, transport, ship-building, the

distributive trades and offices were omitted. It is emphasized that the object of the inquiry was not to influence employers on the subject of rest pauses, or to give advice, but simply to record the facts of existing practice, and to discuss the views of those who contributed to the inquiry.

Rest Pauses.—It was found that 52.9% of the factories visited made provision for official rest pauses, either in the morning or afternoon. The percentages for the factories in London, Birmingham and Manchester areas were notably high, and the report discusses the reasons for the lower percentages of other areas. A rest-pause of ten minutes taken two hours after the beginning of a four and a half hour shift in the morning and a four hour shift in the afternoon was the most frequent occurrence. The report shows that more than half of the factories visited, which have rest pauses, have introduced them during the past decade. The increase was particularly marked during 1938 owing to the introduction of new regulations in the Factories Act requiring rest pauses under certain conditions.

Refreshments.—It was found that in practically all instances official rest pauses were spent in taking refreshments, and refreshments were consumed in many factories where no official rest pauses were in operation. Of all factories visited it was stated that 70.2% had some form of refreshments. A wide variety of foods and drinks was found when refreshments were analysed. Bread (including sandwiches) was the most common form of solid food, and was consumed in 79.0% of the factories having refreshments. Tea was the most popular liquid refreshment, and was consumed in 89.6% of the factories. Cakes (60.9%) and milk (42.4%) were the next most common. It was found that the employers more frequently supplied, and paid for, drink than food, though it is pointed out that where refreshments are sold to employees they are almost invariably sold on very favourable terms, and even where employees provide their own refreshments the employer may supply such requisites as hot water, heating facilities, accommodation, glass and crockery.

Employers' Views on Rest Pauses and Refreshments.—One of the most interesting sections of the report is that in which the views of employers regarding rest pauses and refreshments are discussed; 82.0% of those employers who gave information relative to the effects of rest pauses on efficiency considered that the effects were good, while only 3.4% regarded the results as unfavourable. The report indicates, however, that properly organised rest pauses are more frequently successful than others. Although the primary object of rest pauses is to reduce fatigue and nervous strain, it appeared that other reasons influenced employers more when introducing rest pauses. The most important of these reasons were the need of refreshments by those, especially young girls, who had inadequate breakfasts; Factories Act requirements; and the desirability of regularising unofficial rest pauses which employers had found to be unsatisfactory.

Music in Factories.—The Report includes an interesting appendix on the use of music in factories. Music may be used either during meal-times, rest pauses or working hours. The Report is particularly concerned with those factories where music is used during working hours. It was found that 47 of the 970 factories giving information about this used music at such times. None of those employers who had music reported any bad effects, and a considerable majority considered it useful in increasing efficiency. The report suggests that there is need for further investigation into the relationship of music to other methods of reducing fatigue and boredom, but points out that "the need for refreshments, and consequently the desirability of rest pauses, suggests that music should be used rather to supplement them than to take their place."

SMALL TOOLS.

Ardoloy. (*Machine-Tool Review, May-June, 1939, Vol. 27, No. 170, p. 326, figs. 7*).

The application of Ardoloy tools. Machining cast-iron, nickel-chrome steel forgings, phospor-bronze, by turning, drilling and milling operations. The different grades of this tungsten carbide and the corresponding cutting speeds are given with good illustrations of pieces and tools.

Cutting Tools for Cast-Iron, by H. H. Beeny. (*Engineering, June 30, 1939, Vol. CXLVII, No. 3833, p. 789*).

Cast-iron does not impose heavy destructive stresses upon the tools, but the position in regard to abrasion and heating is quite different. Leaded-brasses, magnesium and most aluminium alloys can be turned at 1,000 ft. to 2,000 ft. per minute with carbide tools, whereas grey cast-iron of roughly similar tensile strength and no ductility has to be removed at much lower speeds, which vary from 120 ft. per minute for a strong, close-grained low-phosphorus metal up to 800 ft. per minute for a soft-annealed well-fettled casting. In good quality irons the combined carbon is in the region of 0.70% or 0.80%, so that the matrix is pearlitic and corresponds to the composition and structure found in high-carbon steel. An annealing treatment which destroys the constituent (combined carbon) converting it to soft ferrite and graphite, makes a marked improvement in the speed and ease of handling in the machine shop. With the same traversing feed, cutting speeds may be doubled while multiplying the life of the tool from three to six times. It is unfortunate from the machining point of view that the annealing of irons of commendable quality reduces the wear resistance in addition to the strength, so that it is an unsuitable process for many castings. The important influence of combined carbon extends to mottled and white castings, where the constituent appears in the massive as well as in the pearlitic form. Speeds are much reduced, as one would expect, but with a suitable grade of sintered-carbide tool, white cast-iron possessing a Brinell hardness number around 415 can now be successfully turned, the cutting speed being about 25 ft. per minute. This contrasts with a turning speed of from 200 ft. to 500 ft. per minute for an average unannealed grey iron possessing a Brinell number of about 200 (5-mm. diameter steel ball, 750 kg. load). The practice in the workshop is, therefore, to take a deep cut and so get well under the harmful layer. With ordinary high-speed steel tools the blunting effect of the casting skin is very noticeable, but the carbide tools are much more resistant, so that when foundry considerations permit, machining allowances can be reduced. These tools are also invaluable for dealing with castings which are chilled in places or are generally too hard, such castings creating great difficulties for the older types of tool. The turning, milling, drilling and planing of cast-iron are almost invariably done dry. Cutting speeds of 200 ft. to 250 ft. per minute may be taken as average machine-shop practice for turning grey cast-iron with carbide tools; this compares with 140 ft. per minute for Stellite and 70 ft. per minute for 18% tungsten high-speed steel, all the cuts being taken dry. On machine tools embodying the latest construction and design still higher speeds are attainable with greater savings. The new super-cutting materials consist of minute particles of intensely hard metal carbide, which are cemented together with cobalt by a final sintering process in the neighbourhood of 1,500°C. Tantalum, titanium and molybdenum carbides are also used. Such tips have a Vickers pyramidal number of fully 1,545. A grade for general work on cast-iron retains the fineness of the constituent powder, but has extra cobalt to cement the grains more firmly together. The additional cobalt reduces the indentation hardness slightly, so that the Vickers pyramidal number falls to about 1,478. For planing or for intermittent cutting on grey cast-iron a softer and tougher grade is available, which has coarser particles of tungsten carbide and a larger proportion of cobalt. The average Vickers pyramidal number for this grade is 1,372.

New Cold-Set Diamond Tools. (*Mechanical World and Engineering Record, July, 1939, Vol. CVI, No. 2741, p. 28, figs. 5*).

The new tools are fitted with completely rotatable diamonds having a plurality of cutting edges. When it becomes unserviceable in one zone a small rotation of the diamond in its spherical seating, after releasing the clamping means, enables a new cutting edge to be brought into the operating position. Tools are made with three four, six, eight and 16 cutting edges, and there is also a completely circular diamond for turning or boring. Shapes to which diamonds are cut to give a number of cutting edges. Settings for different cutting angles. Rotatable boring and turning tool. Besides the obvious advantages in adjusting and handling multiple facet diamonds of this kind, the durability of the tool is increased, as it is possible to utilize all the facets until it is necessary to send the tool for relapping. The diamonds are cold-set in steel holders after being polished all over.

SURFACE TREATMENT.

Modern Painting Practice for the Protection of Iron and Steel and Industrial Non-Ferrous Metals, by D. G. Darroch. (*The Australasian Engineer, May 8, 1939, Vol. 39, No. 276, p. 13*).

The protective properties of paint materials are considered according to : (1) Classification of the more important rust inhibitive pigments and their comparative values as primers. (2) Classification of the more recently developed paint pigments. (3) Classification of media used in the so-called synthetic paints and enamels. (4) Brief description of methods of grinding and incorporating pigments and media. (5) Suggestions for the effective painting of metal surfaces of : (*a*) Iron and steel ; (*b*) Industrial non-ferrous metals. Preparation of metal surfaces by mechanical means and chemical pre-treatment. Priming. Finishing. Conclusions : (1) Pouring temperature is extremely important. (2) Copper is not improved by heat-treating the casting form. (3) Gunmetals are improved by annealing. (4) Aluminium bronze shows a marked response to various heat treatment practices. (5) Copper-zinc alloys do not respond to improved physical properties by heat treatment. (6) Introduction of a third element to brass introduces temperature ranges of a critical nature. (7) Introduction of other elements complicates the heat treatment.

WELDING.

Welding Techniques and Methods, by F. Clark, A.M.Inst.W. (*The Welding Industry, July, 1939, Vol. VII, No. 6, p. 201, figs. 4*).

The article has been written for the purpose of giving a brief survey of the gas welding methods available to-day, with an indication of their various advantages and efficiency. The oxy-acetylene flame. Flame adjustment. Gas pressures. Correct choice of welding wire and flux. Three types of flame adjustment : (*a*) correctly adjusted neutral flame ; (*b*) excessive pressure, harsh flame ; (*c*) oxidising flame. Welding techniques. Leftward welding. Rightward welding.

Effective Control of Strength and Soundness in Fillet Welds by Welding Procedure Limitations and Inspection, by E. P. S. Gardner. (*The Institute of Welding, Quarterly Transactions, April, 1939, Vol. II, No. 2, p. 69, figs. 26*).

Section A.—The influence of procedure on the occurrence of hidden faults : (*a*) The influence of variation in the ratio of size of fillet deposited to the

gauge of electrode employed. (Tests carried out with Nos. 10, 8 and 6 gauge electrodes in Alternating Current.) (*b*) The influence of the current value used. (*c*) The influence of plate thickness. (d) Check tests using Direct Current. (*e*) Check tests using various types of electrodes. (*f*) Check tests on Tee specimens with rolled edges on "stalk" or perpendicular plate. (*g*) Works check tests. (*h*) Check tests using large diameter electrodes.

Section B.—The influence of root penetration on the strength or static load-bearing capacity of fillet welds: (*a*) End or traverse fillet welds. Butt strap specimens. Lap joint specimens. (*b*) Side or longitudinal fillet welds. Reference to report of the welding panel steel structures. (Research Committee, D.S.I.R.) Many tables and excellent illustrations mark this important report.

Forces Acting During the Transfer of Material Through the Welding Arc, by J. Slack, Jr. (*The Welding Industry, July, 1939, Vol. VII, No. 6, p. 234, figs. 15*).

The subject in question deals with the fundamental problems of the process of welding. The appearance of the X-Ray slow-motion cine-camera with side panel removed. The films show us that the formation of the drops usually takes place within the coating. The force of gravity. Further, a force is acting which pushes the welding rod away from the plate and which is dependent upon the current strength. X-Ray cinematographic film (50 pictures per second) of the drop in overhead welding. Propelling forces. Transfer of liquid material from the welding rod to the piece of work. Surface tension. Electro-dynamic forces. Current lines in the welding rod and drop. Explosive forces. Preparation for an explosion. A vapour or gas bubble is formed in the interior of the neck. A possible explanation for the voltage pictures observed.

Shrinkage Stresses in Arc-Welded Structures, by H. V. Wenger, Jr. (*The Machinist, July 22, 1939, Vol. 83, No. 24, p. 338e, figs. 6*).

This article reports the experience of the J. D. Adams Co. with a Diesel engine frame fabricated from structural plate by arc welding. It is a safe rule to assume that steels with a carbon content above .35% can only be welded by using special procedure. Fortunately for the designer there are high tensile, low alloy steels with yield strengths of approximately 60,000 lb. to 70,000 lb. per sq. in. For still higher strengths the designer can specify the chrome-nickel stainless steels, for they are easily welded. The shrinkage may result in distortion of the structure or may be confined to residual stresses. The restraint which causes residual stresses arises from either of two sources: anchorage of the side or ends of the members being welded, or resistance of the parts themselves to distortion during welding. Residual stresses are commonly divided into those parallel to the weld and those perpendicular to the weld. The illustrations show residual stresses and welding sequence. Stress-relieving may be performed by either thermal or mechanical means. The most common thermal method is to put the whole structure in a furnace which can be heated to 1,100 to 1,200°F. for mild steels and higher for alloys. Graphs of residual stresses in butt welds, etc. By peening the passes while they are still hot with a peen hammer or blunt air chisel, the residual stresses can be partly relieved by the plastic deformation which occurs. Residual stresses will differ in direction with the welding procedure employed. In butt welds the stress will be greatest if the plates are prepared for a V-type weld, slightly less for a U-type weld, and considerably less for a X-weld (double V). Graphs of the residual stresses in the joints.

Flash-Butt Welding of Alloy Steel Tubes (I), by Wilhelm Denker. (*The Welding Industry, July, 1939, Vol. VII, No. 6, p. 209, fig. 1*).

The author discusses the process of welding alloy steel tubes by the flash-butt welding process. He shows that a high upsetting pressure must be applied just as with ordinary steel tubes. One of the difficulties encountered is that the increased pressure of the air inside the tube causes oxidisation of the weld, especially in the case of a chromium-steel tube, but this can be prevented by surrounding the weld with a protective atmosphere.

Welded Pipe Joints. (*Mechanical Engineering, July, 1939, Vol. 61, No. 7, p. 543, fig. 1*).

Comparatively recent increases of steam temperatures and pressures in modern stations have imposed rigid requirements on joints in piping for this service. Carbon-molybdenum steel, because of its good physical properties and resistance to creep at high temperature has been generally accepted as the base material for the pipe, and welding as the most satisfactory method of joining it. However, since there are differences of opinion regarding groove design, detailed welding procedure, methods of inspection, and heat treatment subsequent to welding of joints, R. W. Clark, engineer in the works laboratory, General Electric Company, Schenectady, N.Y., carried out two sets of tests to clear up these various points. The tests were made according to the following procedure : (1) Establish and qualify the welding procedure. (2) Qualify the operator under the procedure. (3) Properly supervise and inspect visually during welding.

Reclaiming Steel Tyres by Flame Cutting. (*Mechanical World and Engineering Record, June 30, Vol. CV, No. 2379, p. 641, figs. 9*).

American mines have developed procedures for flame-shaping worn locomotive tyres to the extent that the operation might well be considered semi-production in nature. The job is performed with a portable cutting machine and requires a number of successive cuts in definite sequence for its successful completion. $\frac{1}{4}$ in. or $\frac{3}{4}$ in. of steel may be worn from a tyre in less than three months. This wear usually occurs next to the flange. The truck is removed and positioned vertically on one end. There is no need to remove the wheel from the truck. Typical example of the way which tyres are worn in service. Sequence of cuts used for reclaiming tyres. Alternative method involving the use of preheating and post-heating. A vertical cut is made in the true flange. A bevel-cutting adaptor is used for cutting the bottom bevel of the flange. The top bevel of the flange completes the sequence of machine-cutting operations. The heating apparatus consists of a seven-flame head attached to a welding blowpipe mounted on a horizontal tube which carries the cutting blowpipe. The cost of reclaiming a tyre by flame-cutting is less than half that required for machining. The exact savings depend, of course, upon the size and condition of the tyre.

The Autogenous Welding of Electron Metal. (*Aluminium and the Non-Ferrous Review, June, 1939, Vol. 4, No. 7, p. 225, figs. 16*).

The specific weight of electron metal is only 1.8 as against 2.7 of pure aluminium, which is thus 50% heavier than electron metal. Cast aluminium, alloyed with zinc or copper, has a specific weight of about 2.9, and is about 60% heavier than cast electron metal. Physical properties. Mechanical

properties. Suitability of various alloys for welding. Method of operation of autogenous welding. The welding equipment. The welding flux. The welding rods. The seam arrangements for sheets and sections. The arrangement of the seam for castings. The process for sheets and sections.

The Welding of Non-Ferrous Metals, by E. G. West, Ph.D., B.Sc. (*The Institute of Welding, Quarterly Transactions, April, 1939, Vol. II, No. 2, p. 97*).

A review of published information. The first step in the research which is being carried out by the Sub-Committee on the Weldability of Non-Ferrous Metals of the Research Committee of the Institute. The information has been collected by the author at the laboratories of the British Non-Ferrous Metals Research Association, which is co-operating in the investigations. (1) Welding processes: gas welding, arc welding, atomic hydrogen welding, resistance welding, other processes. (2) General problems of a fundamental nature: evaluation of weldability, shrinkage, internal stress and distortion, variation of properties with temperature, effect of heat on the base metal, chemical and physico-chemical reactions. (3) Methods of testing welds: non-destructive tests, destructive tests. (4) Technique and application for individual metals: aluminium and its alloys, copper and its alloys, nickel and its alloys, lead, silver, magnesium, zinc.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ACCOUNTING, ADMINISTRATION.

Management in the Small Plant, by Lillian M. Gilbreth. (*Mechanical Engineering, August, 1939, Vol. 61, No. 8, p. 579*).

Small plants, like small businesses, play an important part in industry to-day. The small plant offers an excellent opportunity for experiment with management techniques, as well as for the training of personnel. Some factors that affected early management installations in U.S.A. Techniques available to small plants. Gathering and consulting data. Advantages and disadvantages of small plant. Small industries can justify their existence in the fact that they are of such size and nature that careful observation of their functions can be readily maintained.

BELTS AND ROPES.

The Application of Transmission Belting—VI, by H. Stuart Jude. (*Power Transmission, July 15, 1939, Vol. 8, No. 90, p. 349, figs. 3*).

Belting joints. Belts built endless. (1) Laminated leather. (2) Link leather. (3) Some brands of woven belts. (4) Particular brands of rubber belting having one long continuous cord as the tension member. Spliced belts. Leather lacing. Wire hooks. Hinged fasteners. Bar-type fasteners. Plate fasteners. Care and maintenance.

The Protective Action of Lubricants for Wire Ropes, by J. E. O. Mayne. (*Engineering, August 11, 1939, Vol. 148, No. 3839, p. 157, figs. 4*).

One of the most important methods of preventing the corrosion of a colliery winding rope during service is the application of an external lubricant. In order to obtain some information regarding the relative values of different lubricants, when there is a tendency for the oil film to be broken, an empirical test has been developed. The following lubricants were selected for testing in the apparatus. (1) A viscous dark-yellow cylinder oil having a viscosity of 2,973 seconds Redwood No. 2 at 25°C. (2) Oil No. 1 plus 2% oleic acid. (3) Lanoline. (4) Petrolatum. (5) An asphaltic oil of the fuel-oil type which had a Redwood No. 2 at 25°C. during the experiment. (6) A heavy asphaltic oil having a viscosity of 614 seconds Redwood No. 1 at 100°C. Oils Nos. 1, 4, 5, and 6 were free from animal or vegetable oils. When wires coated with films of the above oils were tested in the apparatus it was found that wear was reduced and the endurance greatly increased. The experiments described show that the most protective type of lubricant for the lubrication of colliery wire ropes in service is one containing asphalt. The thicker the lubricant the greater the protection against corrosion.

COOLANT, LUBRICANT.

Automatic Lubrication of Moving Machine Units, by F. M. H. (*Machinery, August 3, 1939, Vol. 54, No. 1399, p. 561, figs. 9*).

Automatic lubricating systems for moving unit mechanisms of machine tools have greatly facilitated the solution of the problem of dependable lubrication. Diagrammatic plan view of the automatic lubricating system applied to a horizontal broaching machine. Lay-out of the automatic lubricating system for the Giddings & Lewis boring machine. Diagram showing the application of an automatic lubricating system to the turret of a lathe. Cross-slide carriage of a heavy-duty turret lathe equipped with an automatic lubricating system. Diagram showing the Bijur System applied to the cross-slide carriage of a Warner and Swasey turret lathe.

FOUNDRY, MOULDING.

Modern Foundry Methods. (*Machinery, August 17, 1939, Vol. 54, No. 1401, p. 625, figs. 8*).

New equipment installed by Ferranti, Ltd., Hollinwood, to facilitate production. Battery of Jackman-Osborn moulding machines in the continuous casting plant. Dial gauge inspection and testing of non-magnetic castings. Vertical core-drying stove. Checking patterns for use in the continuous casting plant.

Plastic Moulding Machines. (*Engineering, July 28, 1939, Vol. 148, No. 3837, p. 106, figs. 2*).

An injection moulding type of unusual interest is illustrated. The machine is disposed horizontally with the movable die and its operating cylinder on one side, and the fixed die with the material feeding gear opposite. The machine can be arranged so that the several movements made during an operation are manually controlled, or can be used with semi-automatic or full automatic operation. The motor is of 15 h.p., but the full power is required for approximately two seconds only of the injection cycle. The closing pressure is 100 tons. The machine is being used in this particular illustration, for moulding ordinary combs. These combs can be produced at the rate of 720 per hour. The injecting part of the machine is well understood from the sections of the nozzle and heating cylinder. The ram of the machine is actuated by a plunger 9 in. in diameter by 6 in. stroke, which works at a speed of 140 in. per minute. The pressure on the material is 9 tons per sq. in. with a pump delivery pressure of 1,000 lb. per sq. in. The pressure on the plunger can be varied between 1,000 lb. and 500 lb. per sq. in.

GEARING.

The Brown-Boveri Testing Apparatus for Gear-Wheel Material, by A. Meldahl. (*Engineering, July 21, 1939, Vol. 148, No. 3836, p. 63, figs. 12*).

The stresses to which modern gears are subjected are high ; the formula of Hertz, when applied to the tooth faces of turbine gears, gives stresses of about 200 tons to 250 tons per sq. in., while in motor car or aeroplane gear values of up to 450 tons per sq. in. and above are reached. Only in roller bearings are stresses of similar order to be found ; but whereas the movement of the rollers within the bearing is one of rolling only, considerable sliding movement occurs as well in the case of gear teeth. In high-speed gears the sliding velocity between teeth in contact may be as high as 50 ft. per second. The condition of meshing both on a driving tooth-face can be

reproduced on the circumference of cylindrical test pieces if the two shafts are coupled by eccentric involute gear wheels. The Brown-Boveri testing machine for gear materials has been designed on these lines. The test pieces are shrunk on to the shafts and are, moreover, held in position by a pin which engages in a hole in the test piece. Kinematics of new test apparatus. Four distinct, movements of the gear wheels I, I^1—II,II^1 are possible, namely: (1) wheel I may rotate round I^1; (2) wheel II may rotate around II^1; (3) the two wheels may rotate around each other at a constant distance " a," each wheel retaining its direction in space; (4) the distance " a " may vary. Discussion of results. Carbon-steel, nickel-steel and chromium nickel-steel rollers were tested at 1,000 r.p.m. under a load of 1,700 lb. per in. linear pressure. The formation of pitting. Examples of destroyed test rollers are shown. The tests were con tinued in order to find means of avoiding seizing. These indicated that seizing could be avoided by the careful running-in of the test pieces. Attempts were also made to prevent seizing by using more viscous lubricating oil. If the test pieces were lubricated with cylinder oil no seizing occurred. No difference was found with regard to material, the pit size being, in general, the same for soft carbon steel as for hard chromium nickel-steel. The influence of speed on the strength of the tooth-face material will be investigated later.

JIGS AND FIXTURES.

Plastic Tools and Jigs. (*Report—Aircraft Production, August, 1939, Vol. I, No. 10, p. 335, figs. 5*).

The use of reinforced synthetic material in metal aircraft construction; a new method at the Arado Works in Germany. A group of tools made from synthetic materials; a blanking tool made from hard paper with steel-plate cutting edges, a forming tool for wing ribs, and a universal forming tool for interchangeable punches and dies. A combined milling and drilling jig and a drawing tool. In each case a workpiece is shown with the tool.

The Lang-Forkardt Power-operated Three-jaw Chuck, Type KL. (*British Machine Tool Engineering, July-August, 1939, Vol. XXI, No. 118, p. 205, figs. 13*).

The Lang-Forkardt power-operated chuck is designed and manufactured to fulfil the need for a powerful and accurate gripping device to ensure that the maximum output is obtained from modern machine tools. A sectional view of the Lang-Forkardt power-operated three-jaw chuck. The chuck must be supported by the whole of the adaptor face. The application of the Lang-Forkardt power-operated chuck and its power unit equipment to the lathe spindle (section drawing).

Methods of Clamping Sheet Metal for Riveting, by Dr.-Ing. C. H. Plock. (*Aircraft Engineering, August, 1939, Vol. XI, No. 126, p. 317, figs. 7*).

It is usual before the final riveting to clamp constructional parts made of sheet metal. The parts are then taken out of the jig coupled together, so that they cannot shift out of place. Then as they are riveted the temporary clamps are taken out one by one. Types of nut and bolt used for clamping. Riveting clamps with hooks. Riveting clamps with sliding wedges. Myers riveting clamp. Riveting clamps with split taper-pin legs. Special type of pliers.

MACHINING METALS.

A Treatise on Toolroom Grinding. (*The Carborundum Co. Ltd., Trafford Park, Manchester 17*).

This book on toolroom grinding is an attempt to bring to the grinding wheel user a better understanding of grinding wheels and their relation to the various operations of tool sharpening and miscellaneous grinding performed in the tool room. The reader gains a clearer understanding of grinding wheels, what they are and how they perform and thereby produce improved work more efficiently.

Über das Feinschleifen von Hartmetallwerkzeugen mit Borkarbid (*Concerning the lapping of cemented carbide tools with boron-carbide*), by W. Dawihl and E. Wesenberg. (*Werkstattstechnik und Werksleiter, August 1, 1939, Vol. 33, No. 15, p. 373, 9 figs.*).

Comparison of working time of lapping with a fine carborundum disc and with loose boron-carbide (grain 60 : 100). Average values of output with ten turning tools. Lapping of cemented carbide tools with a disc of grey cast iron and a paste of boron-carbide. Design of a cup grinding disc of cast iron to receive a mixture of boron-carbide and oil.

Barrel Polishing, by Dr. E. G. West. (*Machinery, July 20, 1939, Vol. 54, No. 1397, p. 501, 1 fig.*).

The essential requirements of a suitable abrasive may be summarised as follows : (1) It must be harder than the surface of the metal to be polished ; (2) it must be mechanically stable, that is to say, it must not powder readily, and in any case, must always present sharp cutting edges.; (3) it must be insoluble and chemically inert in any of the liquids employed ; (4) it must be non-deliquescent and unaffected by any of the constituents of the atmosphere of the workshop, including acid fumes ; (5) it must be capable of being graded for particle size ; (6) a high density is often of value ; (7) if possible, the colour of the abrasive should be near to that of the metal ; (8) the abrasive selected should be readily procurable and inexpensive. Table on industrial abrasives and their constituents. The actual range of size chosen depends on the dimensions of any holes, slots engraving, or indentations in the articles treated, and it is imperative that sufficient margin is allowed for wear and breakdown from the original size, if clogging in slots, etc., is to be avoided. Balls and other shapes, must be hard, clean, smooth, and preferably of chrome steel, but their actual form is not so important, flat spots not being detrimental. The size of the balls used again depends on the articles treated, the general rule being that the largest possible diameter gives the most economical result, owing to the greater pressures obtained.

Form-cutting Attachment for a Slotting Machine, J.R.W. (*Machinery, July 27, 1939, Vol. 54, No. 1398, p. 531, 2 figs.*).

A slotting-machine attachment designed for profiling or shaping a cam. Any desired shape within the range of the attachment can be machined by replacing the guiding cam with one having the required shape or contour.

SHEET-IRON WORKING.

Forming Dies, by C. W. Hinman. (*The Machinist, July 29, 1939, Vol. 83, No. 25, p. 476, 9 figs.*).

Usefulness of the spring-pad principle in bending and forming dies. This principle of bending in opposite directions simultaneously is easily accomplished and shown by examples. Design of a cutting-off and bending die for forming a bracket in one operation. The method for bending four angles. A die with side-forming cams. A collapsible punch for forming and stripping deep bends. Method for forming a circular tube in two operations. Swinging die members avoid necessity for two operations to form the piece.

Researches of the Deep-drawing Process. (Report—*The Metallurgist*, supplement to *The Engineer, August 25, 1939, p. 57, 6 figs.*).

A comprehensive study has recently been published by S. Fukui-Tokyo, on the mechanism of a simple drawing process for the pressing of cylindrical cups from flat circular blanks. A special apparatus was constructed, in which the drawing or punch load and the blank-holder load were measured by the piezo-electric effect on two quartz crystals. Effect of radius of die and of punch head. Effect of speed. Effect of lubricant. Limiting holding force required to prevent wrinkling. Effective drawing force. Strength of deep drawing. Limit of drawing and comparison of materials. Drawing by conical die. Surface and thickness strains during pressing. Redrawing.

Assembling Dies, by C. W. Hinman. (*The Machinist, August 12, 1939, Vol. 83, No. 27, p. 524, 9 figs.*).

Press-fitting assembly of a shaft to a gear cam, pawl, or collar. Bumper pins should be provided in press-fit assembly dies to compensate for inaccurate movement of a worn press slide. In ring staking, the metal is forced either inward or outward by plastic flow. A four-segment staking ring has the cutting edge disposed to force the metal outward and into a countersunk hole. Metal around the hole in the plate is staked inward around the knurling on the shaft by the action of the two staking rings. A hardened nut is assembled to a plate by using the nut as a perforating punch. In an inverted die, the nut cuts a slug into the die, and the knockout pin ejects the slug at the top of the stroke. Two fibre spool heads are assembled and shear staked equidistant from the ends of the metal core, using a die with opposed swinging leaves for aligning the three parts. When work diameter permits, a spring pad is used in the horn for lock-seaming, and sometimes the hooks can be formed in the spring pad. Steps in making a lock seam. A good method producing the hooked ends through use of a V-bender die.

MANUFACTURING PROCESSES.

Machining Austenitic Stainless Steels. (*Machinery, August 10, 1939, Vol. 54, No. 1400, p. 590*).

Many machinists hold the erroneous opinion that 18/8 stainless steels are hard. On the contrary they are extremely soft and ductile, otherwise it would be impossible to utilise them for deep-pressing and similar work. As in the case of austenitic manganese steel, however, the surface is subject to rapid workhardening. The machining of these steels, therefore, demands special

precautions and technique. It is essential that both the tool and the work should be rigid. The tool must also be prevented from idling or rubbing in the cut, which leads to spinning and work-hardening. For normal turning operations on 18/8 steel in the rolled state, a rake angle of about 15° to 20° will prove successful. For cast 18/8 steel it may be advisable to employ a rake angle of as little as 5°, with 10° to 12° as an average. Normal speeds are 40 to 60 ft. per minute for rolled 18/8, and 20 ft. per minute for castings of the same steel. Medium or large holes can be drilled without undue difficulty with standard 18% tungsten high-speed steel twist drills, such as are employed for mild and medium carbon steels. Peripheral speeds should range approximately from half up to two-thirds of those used for mild steel. in conjunction with a rather higher light feed. In drilling small holes, extreme care is essential. For holes of $\frac{1}{4}$ in. and smaller 18% tungsten high-speed steel, straight shank jobbers drills, such as are employed for ordinary work, should be used. Threads should, wherever feasible, be cut by a regular continuous forward movement, and reversing should be avoided as far as possible. A satisfactory lubricant for this work is a mixture of tallow and white lead thinned with boiled linseed oil. The three successive actions in milling namely, sliding, crushing, and cutting, are particularly prone to produce work-hardening of 18/8 steel. For this reason, cutters must be maintained in the sharpest possible condition, and care should be taken to prevent chatter.

Fabrication des ressorts a lames superposees (*Manufacturing of laminated (leaf) springs*], by L. Scherer. [*La Machine Moderne, July, 1939, No. 373, p. 533, 13 figs.*).

Laminated springs are composed of steel leaves of equal width and equal thickness, bent according to arcs of concentric circles and with equal steps. calculation of the leaf. Kinds of steels used for its manufacture. Preparation of the leaves. Bending and hardening processes. Drawing the temper. Survey of the heat treatment of the leaves. Assembly of the laminated body and its test of strength and elasticity. Manufacture of the hinge of spring or the bridle. Hot fitting of the hinge. Painting of the leaves.

The Production of Coins. (*Machinery, August 3, 1939, Vol. 54, No. 1399, p. 555, 11 figs.*).

General view of the Heaton Coining Press. Diagram showing arrangement of the toggle mechanism of the Heaton press. Arrangement of the toggles on the Taylor & Challen press. Counting and checking the coins.

Large Flying-Boats in Series. (*Aircraft Engineering, August, 1939, Vol. XI, No. 126, p. 319, 36 figs.*).

The methods by which civil and military flying-boats are built at Rochester.

Assembling the Flamingo, by J. A. Oates. (*Aircraft Production, August, 1939, Vol. I, No. 10, p. 339, 31 figs.*).

Part I. Modern methods in the high-speed production of the first all-metal De Havilland Aircraft.

Building the Cheetah Engine, by S. W. Hiscocks. (*Aircraft Production, August, 1939, Vol. 1, No. 10, p. 351, 27 figs.*).

Sequence of machining operations on the main components : assembly ; initial and final test.

Shell Machining Methods. (*Machinery, July 20, 1939, Vol. 54, No. 1397 p. 493, 11 figs.*).

Operations in the production of the 3.45 in. H.E. shell

MATERIALS, MATERIAL TESTING.

The Strength of Metals at Elevated Temperatures, by Richard F. Miller. (*Mechanical Engineering, August, 1939, Vol. 61, p. 589, 18 figs.*).

Knowledge of the behaviour of metals under stress at elevated temperature is becoming increasingly important to the engineer. Photomicrograph of strain-free, low-carbon steel showing irregular outlines of ferrite grains. Stress-strain diagram of low-carbon steel resulting from a room-temperature tensile test. Stainless steel after cold working to produce slip lines in grains. When a metal is stressed beyond its elastic limit, two opposing processes, strain hardening and softening, always take place. At low temperature, softening is very slow and strain hardening predominates. As the temperature increases, the rate of softening or tempering becomes greater and the rate of strain hardening becomes less. Method of determining creep resistance of steels. Creep-testing apparatus used at Research Laboratory of United States Steel Corporation. Shape of the creep curve. Determination of nominal creep strength. Variables which affect creep strength. Grain size. Heat treatment. Previous strain hardening. Short-time tests. Research on the behaviour of metals at elevated temperatures has led to the development of new and stronger steels.

The Sliding of Metals, Frictional Fluctuations, and Vibration of Moving Parts, by F. P. Bowden, L. Leben, and D. Tabor. (*The Engineer, August 25, 1939, Vol. CLXVIII, No. 4363, p. 214, 18 figs.*).

Sliding is not a continuous process. The motion may proceed by a process of " stick and slip." Most of the earlier methods of measuring friction do not record these fluctuations because the measuring system usually possesses a high inertia so that only the average frictional force is recorded. In the apparatus employed in these experiments the lower surface was a flat metal plate which was driven at a uniform rate by a water piston. The upper surface, which rested on the plate, was a small curved metal slider, which was attached to a high-frequency device for measuring the frictional force. This force could be recorded photographically in a moving film camera, so that any rapid fluctuations which occurred in it could be measured. Experiments with various metals sliding together showed that violent fluctuations do, in fact, occur in the friction. Three types of sliding. Type 1 occurs when a hard high-melting metal slides on a softer metal of lower melting point. Type 2 is characteristic of a low-melting metal sliding on a harder one of higher melting-point. The behaviour when identical surfaces slide together (type 3) is very different. The real area of contact and the temperature of sliding surfaces. Dissimilar metals : the change from type 1 to type 3. The tests were made

with molybdenum on steel, bearing metal on steel, silver on silver, constantan on steel, tin on steel, platinum on platinum, platinum on silver, steel on steel with different loads. Practical implications. Frictional fluctuations and the vibration of the moving parts. Summary. The exact type of sliding depends upon the relative physical properties, particularly on the relative melting-points of the different metals. The type characteristic of similar metals gives the highest friction and wear. The resultant motion between the surfaces will be complex and will be determined by the nature of the stick-slip, the natural frequency of the system, and the speed of the forward motion.

Erreichbare Festigkeitseigenschaften bei Chrom-Molybdenum-Bausthælen nach Hærtung und Vergueteung. (*Attainable properties of Strength of Chrome-Molybdenum steels after hardening and normalising*), by H. Voss and F. Kraemer. (*Stahl und Eisen, Vol. 59, No. 32, August 10, 1939, p. 913, 41 figs.*).

Investigations of tests and work charges concerning the influence of the section of the piece—$^{3}/_{16}$ in. to 5 in. diameter—and also the chemical composition : 0.14 to 0.5% C. ; 0.8 to 2% Mn. ; 0.6 to 6% Cr. ; with about .25% Mo. ; further, regarding the tensile strength and the hardness in rim and core by quenching in water and oil. Connection between tensile and notching strength. Range of application of the Chrome-Molybdenum normalised steels after quenching. The interesting results are elucidated by a great number of numerical tables, graphs and slides.

Metal for Aircraft Spells Speed and Safety, by F. Beach. (*Sheet Metal Industries, August, 1939, Vol. 13, No. 148, p. 1026, 8 figs.*).

The various designs and methods of construction as developed by the leading aircraft companies. The various methods of joining metals and the numerous means of fabricating strip and sheet into desired shapes. Historical introduction from 1843. Early English designers between the years 1908 and 1910. Why metal construction ? Metal aircraft of to-day are for the most part fabricated from thin gauges of metal sheet. The light alloys, duralumin and hiduminium in particular, by reason of their better strength-weight ratio, are now considered by most authorities to be more suitable for aircraft construction than any available grade of steel sheet. "Atlas" main plane spar section. Main plane rib details. Attachment of ribs to spar. Fuselage construction of Armstrong Whitworth "Atlanta." Structural details of the Armstrong-Whitworth "Whitley." A. W. Ensign : Details of wing span and rib construction.

The Apparatus to Use for Drawing Tests, by J. D. Jevons. (*Sheet Metal Industries, August, 1939, Vol. 13, No. 148, p. 1019, 9 figs.*).

Comparison of cupping test values of soft low carbon steel, bare, and coated with cupro-nickel. Comparison of cupping tests on annealed 70/30 brass, aluminium and zinc, showing influence of thickness of sheet. Set of first-operation tools for deep-drawing a standard cup and a set of re-drawing tools for deep-drawing a standard cup, both in the Erichsen machine. Curves showing variation in load on punch and blankholder during the forming of a simple cup 1 in. diameter from a brass blank $1\frac{1}{2}$ in. diameter and 0.020 in. thick. Tensile tests. Hounsfield tensometer. Factors which may be forgotten. Shape of test-piece. Standard forms of tensile test-piece for thin sheet metal. Method of preparation. Alignment of test-piece.

Oil Resistance. (*Neoprene News, No. 6, p. 5*).

The table shows the behaviour of neoprene and rubber when immersed in various oils.

Immersed in	Temp. °C.	Compound	Percentage increase in volume		
			24 hours	Three days	Seven days
Motor petrol ...	28	Neoprene	29	29	33
		Rubber	84	84	88
Paraffin (lamp oil) .	28	Neoprene	14	23	23
		Rubber	73	78	78
Paraffin (lamp oil) .	100	Neoprene	36	36	36
		Rubber	142	254	Disin'd
Motor oil	28	Neoprene	1	1	1
		Rubber	5	7	11
Motor oil	100	Neoprene	4	8	10
		Rubber	57	108	131
Benzene	28	Neoprene	168	172	174
		Rubber	113	114	122
Cotton seed oil ...	28	Neoprene	—	1	2
		Rubber	6	8	15
Linseed oil ...	28	Neoprene	1	3	4
		Rubber	2	4	7
Turpentine	28	Neoprene	50	67	88
		Rubber	113	116	135

The neoprene compound shows very much less swelling in mineral and vegetable oils than the rubber compound. Benzene, which is an aromatic solvent belonging to neither of these two classes, swells the neoprene compound more than the rubber compound, but when the solvent is allowed to evaporate from the samples, the neoprene compound regains its original size and much of its strength, whereas the rubber remains tender.

MEASURING METHODS AND APPARATUS.

Ein neuer Mengenregler fuer Fluessigkeiten (*A new quantity regulator for liquids*), by H. Garthe. (*Siemens Zeitschrift, July, 1939, Vol. 19, No. 7, p. 301. 10 figs.*).

The quantity regulations of fluids accomplishes the task of keeping the flow (quantity of current per unit of time) either constant or to vary it lawfully depending on another value. Liquid-counters, which measure the delivered quantity either by the numbers of revolutions or by the strokes of the measuring element, are in frequent use both for the purpose of accounting and for the survey of the workshop. As examples, the flow-regulator and differential quantity regulators are discussed. Properties of regulations : (1) Self-damping of quantity regulation ; (2) retardation of indication ; (3) co-efficient of cyclic irregularity ; (4) adjusting speed of the governing drive and of the regulating valve. Practical execution of the differential regulator : (1) Description and mode of acting ; (2) adjustment of proportions of mixture ; (3) safety device ; (4) keeping the flow constant ; (5) range of application ; (6) mixtures with more than two components. The differential regulator governed by

compressed air permits the regulation of quantities of fluids by using quantity counters as measuring apparatus. The regulator is specially suitable to make fluid mixtures of all kinds, which ask for a great accuracy of the composition of the mixture.

Investigating Surfaces. (Report—*The Automobile Engineer, August, 1939, Vol. XXIX, No. 387, p. 289, 9 figs.*)

Owing to importance of surfaces in engineering practice, special means of examination have been developed, ranging from the precise and detailed method of Bowden and Rideal, which depends on the measurement of the amount of electricity required to build up an excess voltage on a surface, to the semi-direct optical recording of the profile of a face along the lines of Abbott and Shaw. The method of electron diffraction analysis fills the gap which has so long been apparent in the science of testing. Conditions of diffraction. Diagram of camera used by Finch. Lubricating graphoid surface formed on a cast-iron face. An α - iron skin formed on mild steel. Chromium plating on copper. Chromium plating on iron. Chromium plating on nickel. Cuprous chloride film formed on copper degreased with trichlorethylene.

PHYSICS.

Instruments Incorporating Thermionic Valves and their Characteristics, by E. G. James, G. R. Polgreen, and G. W. Warren. (*The Journal of the Institution of Electrical Engineers, August, 1939, Vol. 85, No. 512, p. 242, 33 figs.*).

In the first part of the paper the authors discuss the main valve characteristics which are of importance in instrument design, and describe types of valves specially designed for instrument purposes. The principles are outlined of the various types of valve instruments for the measurement of alternating voltages (including "slide-back," peak, grid-leak, and anode-bend, voltimeters), and of voltimeters and electrometers for direct voltages, and methods of measuring very small values of current and power are described. Reference is also made to other applications such as harmonic analysis, frequency measurement, and the measurement of physical quantities. The paper concludes with a brief comparison between valve-operated and other types of instrument and indicates possible future lines of development.

Gestaltung und Herstellung der Stahlformen fur Kunststoff Pressteile (*Design and machining of the steel dies for parts of synthetic resins*), by R. Sprenger. (*Maschinenbau-Betrieb, Vol. 18, No. 15-16, August, 1939, p. 385, 11 figs.*).

The design of the press dies belongs to the most difficult task of the press technique. The circle of thoughts is discussed through which the designer goes to get the most favourable shape. Examples : Round box with even and webbed cover, dies which can be opened, correct arrangement of the juncture, numerical values of the shrinkage of synthetic material between 0.25% and 1%, methods of heating, selection of the right steel for the dies. Box methods : Inserting of hardened working surfaces in the exterior casing of soft steel.

STANDARDISATION.

Normalisation des nombres des tours des machines-outils (*Standardisation of the revolutions of machine-tools*), by G. Schlesinger. (*La Machine Moderne, July, 1939, No. 373, p. 525, 9 figs.*).

The author published a booklet on " Substance and Effect of the Standardisation of Speeds " in 1931. This standardisation was based on the " 10 " as basis of our usual system of numbers, the " 2 " to use electric motors of alternating current with the interchange of poles, the standardised number of periods : 50 Hertz, as the frequency used on the Continent and in Great Britain, so that $50 \times 60 = 3{,}000$ as the frequency per minute, was the basic number of the whole system. The range of speeds and feeds in all machine tools of the world is, as a rule, a geometrical progression, and the common ratios were ranged by the series " Renard " with 1.06, 1.12, 1.26, 1.41, 1.58, 2 These ratios are again based on $\sqrt{10}$ and $\sqrt{2}$. The total of these quotients is given by the following table :

Common ratio

Numerical value	1.06	1.12	1.26	1.58	1.41	2.0
By $\sqrt[n]{10}$ ...	$\sqrt[40]{10}$	$\sqrt[20]{10}$	$\sqrt[10]{10}$	$\sqrt[5]{10}$		
By $\sqrt[n]{2}$ ...	$\sqrt[12]{2}$	$\sqrt[6]{2}$	$\sqrt[3]{2}$		$\sqrt{2}$	2.0

The idea of this standardisation is to have either for *all* machine tools the *same numerical* values of speeds and feeds or, at least, for each kind of machine tool. For instance, for all lathes, for all milling, drilling machines, etc., the same numbers on the speed shield of the machine. The advantages are obvious. and great. They facilitate the design of the machine-tool and its manufacture. We have always the same numbers of teeth in the gears, the same distances of axes, the same tools for manufacturing the gears, hobbing, shaping—in short all generating cutters. These are advantages for the *maker*, but they are still greater for the *user* because the *rate fixing department* could always calculate with the same figures for speeds and feeds which were really correct and the same all over the shop. The figures on the piece-tickets of the workmen would be correct ; all guesswork would be eliminated. Finally, the synchronous revolutions of the A.C. motors with changing of poles are included by using the indispensable figure of 3,000 so that the speeds of the electromotor and of the machine tool are based on the same numerical system. This system explained by the above mentioned booklet of the author, has been accepted all over the continent since 1931, because its advantages are striking. It was the object of discussion of the I.S.A. Committee No. 39, and was discussed in July 1938 by that committee in Berlin. The committee took the following resolutions : (1) The series Renard R 40 with the common ratio —1.06 is the basis of the speed standardisation ; (2) the ratios 1.12, 1.26, 1.41, 1.58, completed by the ratio $\sqrt{1.41} = 1.19$ are generally adopted ; (3) the ranges adopted must contain the numbers 2800 and 1400.

The author proves that the first two resolutions are correct but that the third one, which abandons the numbers 3,000 and 1,400, is wrong, and that the reasons given for their use are far from real. This was that for the direct electric drives with an incorporated motor its speed decreases always by loading the machine. Therefore, it would be advisable to adopt for the slip of

the motor an average amount of 6%, so that by multiplying the original series based on 3,000 all numbers of the series R 40 with 1.06 would be decreased to one member of this series. The author proves that the supposition of 6% slip is wrong, that the small motors under one h.p. slip up to 15% and the big motors above eight h.p. slip much less—between 1% and 3%, depending on the design and its more or less good execution. The electricians would not, and could not, abandon $50 \times 60 = 3{,}000$. The series with 3,000 are introduced all over the world. The *incorporated* motor for driving machine tools is not introduced as a general rule, and for all machines where it is used, drilling and milling machines especially, it doesn't matter if the number of revolutions is 6% greater or smaller—it is only a question of *having the same numbers*. First for the lathe and similar machines the incorporated motor on the main spindle is not liked, as it gives trouble on account of the vibration of not fully balanced armatures. Further, the incorporated motor is only useful if it doesn't matter keeping the same power. Constant power, however, is a very useful component in the design of a machine tool, but it can only be kept by very large motors, designed for full power at the smallest speed, else the disposable power depends on the number of revolutions of the motor. The author proves by a typical example of a capstan lathe of Warner and Swasey that by changing the poles of an alternating current motor with four speeds the power is going down from three h.p. to one h.p., and that it is impossible to keep the common ratio constant within the series. The article concludes by giving a table of 16 most modern lathes of British, American, French, Swiss, and German make of the last two years which are all based on the number 3,000, but only six of the 16 have standard ratios; the others have not and if the great and useful aim of standardisation is to be realised it would be very unwise to-day to abandon a well tried standardisation for a new one, the reasoning of which is wrongly based, arguing by an exception and misunderstanding the possibilities of the electrical drive. The author emphasises, however, the necessity for the standardisation of speeds for the future design of machine tools, for the three parties, the *maker*, the *user*, and the *electrical engineer*.

SURFACE TREATMENT.

Surface Preparation for Metal Spray—I. (Report—*The Machinist, August 19, 1939, Vol. 83, No. 28, p. 533, 5 figs.*).

There are four steps in the metallising of any shaft: (1) Undercut the surface; (2) prepare the surface by blasting or grooving with a round-nose tool; (3) metallise with the correct metal; (4) finish the surface by machining or grinding. The undercut should equal the wear allowance plus a "minimum coat thickness." The rounded nose of the grooving tool should be between 0.045 and 0.050 in. wide, and should have a tip radius not exceeding 0.020 in. After grooving, the ridges are roughed by a hardened roll-type knurling tool. The grooves should be cut 0.025 in. Blast cleaning, either with sand or steel grit, is the most extensively used method of preparing surfaces for metallising.

Some Engineering Uses of Heavy Nickel Deposits. (*The Nickel Bulletin, July, 1939, Vol. 12, No. 7, p. 145, figs 5*).

Electro-deposits must have certain controllable qualities, the most important being hardness and strength with freedom from porosity. For resistance to corrosion a deposit of 0.005 in. may be applied. If wear is to be considered as well as corrosion, deposits of 0.020 in. to 0.030 in. may be applied, and for purposes of reclaiming worn components, thicknesses of $^1/_{16}$ in or more can be

applied if the economics of the repair warrant it. More important uses are: (1) The manufacture or reproduction of articles by electrodeposition. (2) Building-up or surfacing by which the deposit becomes part of the original article. The production of heavy nickel deposits: " Fescolising." Machining. Correction of machine shop errors. The repair of worn parts by the " Fescol " process. Surface protection to obtain a harder surface, more resistant to wear, without heat treatment. Parts so treated include marine propellers, turbine blading, Diesel valve stems, wrist pins, etc.

Superfinish, by A. M. Swigert. (*The Machinist, August 5, 1939, Vol. 83, No. 26, p. 364E, 14 figs.*).

Great interest has been shown throughout industry in the superfinishing programme. There is at present no practical way of specifying surface finish. The only way of specifying finish is to indicate on the drawings the process by which the surface is to be produced, whether machining, grinding, honing, burnishing, broaching, lapping, polishing or other method. The main purpose in this article is to compare relative surface smoothness, load-carrying properties and general characteristics. The theory of lubrication assumes perfectly smooth surfaces that will permit streamline flow of lubricant, that is the absence of turbulence. Smooth bearing surfaces are, therefore, necessary. Rough bearing surfaces wear rapidly because of metal-to-metal contact. In the cutting or grinding of metals there is produced by pressure and heat a surface layer of amorphous or non-crystalline structure of the piece being machined. Effect of cutting tool. Grinding effect. Effect of honing. Superfinishing motions. Removal of amorphous layer. Surface velocities between work and wheel are low, of the order of 10 ft. per minute. The pressure of the stone against the work is low, ranging from a few ounces to a few pounds per sq. in. of stone area. Coolant serves not only to cool but also to lubricate. Ordinarily the amount of material removed is negligible, dimensional changes being of the order of 0.001 in. If desired, however, the process can be modified to produce a stock removal of 0.001 in. or more. Rough surfaces for braking will wear rapidly. Superfinish will give the maximum braking surface, smoother action and longer effectiveness and life. Surfaces that can be superfinished include flat, cylindrical, concave or convex, and the time required for superfinishing say piston pins one at a time is not more than 20 to 40 seconds.

Modern Metal Cleaning. (*Report—Mechanical World and Engineering Record, August 4, 1939, Vol. CVI, No. 2744, p. 99, 2figs.*).

The requirements of a chemical process, a discussion of present-day methods, and an explanation of the operating of a typical plant. Sectional view of standard two-liquor plant, showing arrangement of division plates, base and steam heating. Solvents. Properties of Trichlorethylene. Trichlorethylene plants.

TECHNICAL EDUCATION.

Problemes actuels de l'enseignement technique superieur (*Present-day problems of higher technical education*), by M. A. Rohn, Président du Conseil de l'Ecole Polytechnique fédérale. (*Société Royale Belge des Ingenieurs et des Industriels, Bulletin mensuel, No. 6, p. 529*).

Amongst present-day problems of higher technical education the greatest importance is attached to scientific research. (1) General points of view regarding mental, economical, scientific and social order in close connection

with technical education. (2) Necessary conclusions as to the form and spirit of this education. General points. Some personal experiences. Practice—teaching—administration. Budapest Congres, 1936, Paris, 1937. Criticism regarding " Technique," Technique and technical science. Economic demands. Scientific research. Adaptation of higher technical education to more important considerations. Admission to the school. Essential task : scientific fundamentals. Preparation for scientific research. Iustitutes of the Federal Polytechnic School at Zurich. Practical stage : its social side. Social questions. Passing from the school to practical life. Application of the laws of equilibrium to engineering science. On this subject there exists a striking parallel between material and moral sphere. These laws dominate the professional and mental activity of the individual, of the masses and of the State ; they always lead to the re-establishment of order.

A School Where the Pupils are Paid. (*The Factory Manager, August, 1939, Vol. VII, No. 8, p. 423*).

The new Leyland Motors Day Continuation School ; 350 pupils are paid to go there. An outline of the Leyland Motors' scheme for training trade apprentices. Nursing future stars. Work with a purpose. General and engineering training.

TECHNICAL INFORMATION.

Comite Central Industriel de Belgique, 33, rue Ducale, Bruxelles. (*Central Industrial Committee of Belgium—Report, 1939*).

The Federation of Belgian Industries have published the ninth edition, 1939, of their list of affiliated industrial establishments. The present Directory of the Belgian production contains some 3,000 heads grouped according to a logical decimal classification and listed in an alphabetical index. The effect of the objective classification adopted is to group together headings presenting certain affinities and, in that way, to induce buyers and sellers alike to extend to new products the scope of their business. However, in view of the unfeasibility of mentioning all existing articles or giving complete particulars of those appearing in this Directory, prospective buyers and more particularly firms not having so far entered into relations with Belgian manufacturers are recommended to apply to the " Comite Central Industriel " (Federation of Belgian Industries), Offices 33, Rue Ducale, Brussels. This Institution, having at their disposal a complete documentation on Belgian production, will effectually direct inquiring firms to such industrial establishments as are best capable of satisfying their requirements.

WELDING, BRAZING.

The Autogenous Welding of Elektron Metal. (*Report—Aluminium and the Non-Ferrous Review, July, 1939, Vol. 4, No. 8, p. 255, 5 figs.*).

The Griesogen Griesheimer Company are manufacturers of fluxes for welding all non-ferrous metals and also equipment for the same. The fluxes include various designations of Autogal for aluminium and its alloys, hydrogal for hydronalium, electrogal for elektron metal, etc., etc. Procedure for sheet thicknesses of 2.5 mm. (0.1 in.) or more. Cross-section through an elektron-welding 4 mm. thick (alloy AZG). Micrographs from centre of welding—transition stage—material. Pickling treatment. The autogenous welding of castings is more difficult than sheets or sections, both as regards the danger

of flux inclusions and also on account of the possible occurrence of fractures. The sequence of the various processes is : (1) Slow heating of the casting in furnace to 270° to 330°C. (2) Welding. The casting must be protected against cold air. (3) Slow cooling of the casting in the furnace. (4) Careful washing away of the flux. (5) Filing or milling down the excess metal. (6) Pickling (7) Rinsing in water (preferably for two hours in boiling water to which 5% potassium bichromate has been added). (8) Drying the casting. The methods of testing may be classified as follows : (1) External appearance. (2) Tensile test. (3) Investigation of texture. (4) Corrosion test. Elektron metal alloys may be distinguished from aluminium alloys by filing off a few shavings from the part in question and heating them with a weakly adjusted burner. They will ignite with a flash, whilst aluminium alloys do not burn. Concentrated ammonium chloride does not attack aluminium alloys, whilst elektron metal dissolves releasing hydrogen. The differentiation of the various elektron alloys is only possible by analysis.

Erfahrungen mit einem neuen Schmelzschweissverfahren fur duennere Bleche (*Experiences with a new autogenous welding process for thin sheets*), by E. von Rajokovics. (*Machinenbau-Betrieb, Vol. 18, No. 15/16, August, 1939, p. 395, 13 figs.*).

The electric welding process of the Swiss mechanics A. S. and H. Weibel uses essentially two carbon electrodes, which are passed by alternating current of low tension. At the beginning of the process the points of the electrodes are heated until they are red-hot and then guided at the flanged ends which are to be welded. As there is no resistance worth mentioning within the sheet, the heat for welding is created almost entirely in the carbon electrodes outside the piece. Therefore this method is neither resistance- nor arc-welding, it resembles the work done by the electric soldering-iron, but the temperature of working is so high that welding by melting light metals is possible. The tension varies between 4 to 8 volt, therefore the process is working without arc. Description of the " Weibel " welding apparatus with flat electrodes. Preparation of the seam. Technique of welding. Welding-speed up to 0.5 m./min. (20 in./min.). Roentgen photos of the structure of weld. Strength of the welded joint. Influence of the thickness of the piece and of the shape of the seam. Illustrations of the stages of process. Good resistance of the joint against corrosion. The Weibel process is not useful for steel. Main application for aluminium and its alloys. Advantages : the heated zone is narrow, the danger of warping is small, yield point, tensile and bending strength are good, also the resistance to corrosion. Small consumption of flux, and indifference towards the kind of flux. Large speed of welding, relatively simple handling of the blow-pipe.

Heat Control of Resistance Welding Machines by Means of Steel Ignitrons, by B. G. Higgins. (*The Welding Industry, August, 1939, Vol. VII, No. 7, p. 264, 7 figs.*).

" The Ignitron : a Precision Switch for Resistance Welding Control," of the British Thomson-Houston Co. Ltd. Ignitron control lends itself to vary the value of the welding current, in addition to controlling the duration of the current flow, *i. e.*, number of cycles. Accurate control of welding pressure and welding current are necessary if good welds are to be maintained consistently. The function of this equipment is to control accurately the duration of the welding time of spot welds, and of the welding time and non-welding time of seam welds. Timing ranges. Technical description of the circuit. Spot welder control. Seam welder control.

Mechanism of the Welding Arc, by E. F. Newell. (*The Welding Industry, August, 1939, Vol. VII, No. 7, p. 275, 7 figs.*).

Diagrammatic representation of the "welding arc," showing the transference of metal as hollow drops. Oscillograph of D.C. welding arc showing fall in voltage and rise in current, corresponding with the transference of drops of metal. Oscillograph of D.C. welding arc showing voltage variation compared with the sine. The sine curve of A.C. current for timing purposes. Sketches showing the formation of hollow drop on end of electrode. Photographs of sectioned ends of electrodes showing hollow drops of metal. The best solution to overcome "arc blow" is to use alternating current, as with this supply arc blow is absent.

Bronze Propeller Repaired by Electric Welding, by G. J. Foster. (*Electric Welding, June, 1939, Vol. VIII, No. 47, p. 144, 3 figs.*).

Quasi-arc bronze electrodes were used for the work. Approximately 50 electrodes $^{5}/_{32}$ in. diameter, 18 in. long, or 7 lb. were deposited. To make sure no undue strains were set up in the boss, and to insure a reasonably uniform heat while welding, the boss, particularly in the vicinity of the veed-out cracks, was warmed up first. The bronze electrodes were then deposited, just as though it were an ordinary steel job, and continued without undue haste until finished. The bore of the boss had contracted 20 thousandths in the vicinity of the crack. This was afterwards trued up on the boring mill.

WELFARE, SAFETY, ACCIDENTS

Influence of the Production Engineer on Safety, by F. Southwell. (*Industrial Power, July, 1939, Vol. XV, No. 166, p. 213*).

In a paper before the Institution of Production Engineers: Safety in new buildings. The light-lag. Heating and ventilation. The need for an efficient heating system is the need for preserving the sensitivity, deftness, and manipulative qualities of such important tools as fingers. The loss of these qualities is definitely the cause of a very large number of accidents among machine operators. Machine users' responsibilities. Contractors' men, such as painters, are a nuisance in respect of shafting, live wiring, and similar normally "safe by position" situations. The risk taken by outside contractors' men. The guarding of press tools presents one of the biggest problems. Woodworking machinery is always a potential cause of accident and is the subject of special regulations. Electrical accidents. Fire preventing and fighting.

Occupational Shoes, by H. Bradley. (*Industrial Welfare and Personnel Management, August, 1939, Vol. XXI, No. 249, p. 300*).

Shoes and health are intimately associated. It is but a short train of thought that leads us to the idea of "occupational shoes." Influence of shoes on walking. Experimental shoes. The reports received have been most encouraging. Studying shoes in use. Electrical gait recording. Measuring shape of foot. The principal demand upon the boots is that they should be capable of protecting the feet from injury, against falling on slippery floors, protection from hot metals or corrosive chemicals, and so forth.

Eye Injuries in Industry, by Joseph Minton. (*Industrial Welfare and Personnel Management, August, 1939, Vol. XXI, No. 249, p. 305*).

Thousands of eye injuries are sustained every year by workmen by grinding or sharpening tools. Factory Acts and eye protection. Advice to employers. Record keeping. Medico-legal problems. Delayed or indirect optic atrophies. Visual standards in industry. Compensation for eye injuries.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

BELTS AND ROPES.

The Application of Transmission Belting—VII, by H. Stuart Jude. (*Power Transmission, Vol. 8, No. 91, 15 August, 1939, p. 403, figs. 3*).

It is undeniably a fact that many belts have been foredoomed to a considerably shortened life either because they were excessively strained at the time of mounting or because, due to unnecessary haste, the method of installing them was responsible for the gradual development of unequalised strains. The allowance for " initial tension " varies according to the texture of the material, as follows : Oak tanned leather (ordinary) 2%, oak tanned leather (wet stretched) 1%, rubber 1%, balata 1%, hair 1½%. Stretching on a belt : The major fault with roping a belt on the pulleys is that the strain is not equally distributed. The correct method must obviate such imperfections by equalising the strain all down the belt and across the full width. This is done with properly designed clamps and screws. The great advantage of doing the work in this way ensures that every fibre carries its fair share of the strain without damage.

The Application of Transmission Belting—VIII, by H. Stuart Jude. (*Power Transmission, Vol. 8, No. 92, 15 September, 1939, p. 457, figs. 2*).

The driving face : Only when both belt and pulley faces are kept spotlessly clean is proper contact possible. It will be noticed that with dirty driving faces there is an appreciable extent of the pulley width untouched by the belt and this occurs irregularly all over the pulley face. Those portions of the belt which are doing the work are taking a greater strain than they should.

Excessive dressing : The over-liberal use of sticky belt dressing is widespread. In ply belting, as in leather belting, are different strata : the flesh split, the centre split, and the grain or hair split. Sticky dressing is excessively used, it certainly does the job of recreating a firm bond between the belt and pulley, but that same bond has to be broken by sheer force every time the two faces have to part, with the result that belts are quickly destroyed. The application of resin is disastrous to belt life and efficiency. The only function of a belt is to transmit power, and a belt which slips fails to do its work. The sole purpose of dressing is to lubricate the fibres in the belt—(1) to enable it to flex easily, and (2) to conserve the service life. To do the work, it is necessary first to clean the belt thoroughly, picking out any particles of grit which may have become embedded in the leather, and then gently to rub the dressing in by hand equally all over the outside of the belt until as much as can be is absorbed. Periodic testing : Apart from the more obvious things to look for when examining belts, such as misalignment of pulleys, dirty driving faces, belts in need of re-dressing, fasteners working loose and splices lifting, the speed in r.p.m. should certainly be tested. Oil is injurious to most types of belting. One common cure is to coil the belt loosely, place it on edge in a box and completely surround it with sawdust, powdered chalk or some other

material, which will quickly absorb the excess oil ; or better still, to kill the oil with petrol or similar solvent. After treatment, the belt should be cleaned and the joints examined. Guide forks : The use of guide forks is generally imperative, owing to the operating requirements, but they ought never to be the cause of trouble. What is clearly needed is a round bar, with a piece of piping large enough to revolve easily, so that the bare minimum of power is consumed and the belt texture is not damaged. Direction of travel : Belts with splices—*i.e.*, all leather and fabric belts made endless—should be placed on the drive so that the toe of the splice on the outside follows through.

FOUNDRY.

Recent Developments in Foundry Technique. (*Industrial Power and Fuel Economist, Vol. XV, No. 168, September, 1939, p. 269*).

Moulding and core sand ; cupolas. The question of moulding sand is most important, if not the most important item in obtaining good sound castings. To a large extent it must be varied to suit each foundry and the class of casting. Midland sands. Oxide content. Moisture contents. Milling of sand. Core sand. Drying of oil sand cores. Cupolas : The fundamental principle in all cupoias ls the same, that is, to melt the iron with the greatest economy in coke in the shortest time and with the maximum control of the chemical composition of the iron. The types of cupola vary considerably, some being more suitable for producing high quality irons than others. In designing a cupola the following points should be considered : (1) Diameter. (2) Distance from bottom of cupola to tuyeres. (3) Distance from tuyeres to charging door. (4) Number and size of tuyeres. (5) Size of windbelt and blast pipe. Feeding the metal charge. Pulverised fuel. Reduction in ash. There is also an electric furnace now on the market which offers great possibilities, especially in respect to high quality iron, due to the fact that there is a great reduction in coke enabling much more definite control to be maintained.

MACHINE COMPONENTS.

Eliminating Backlash in Lead Screws, by John A. Honegger. (*The Machinist, Vol. 83, No. 32, 16 September, 1939, p. 420E, figs. 15*).

Constructions are based on two general methods : one is relative axial movement ; the other method is adjustment of pitch diameter, which takes up clearance between the sloping faces of the threads. Flexing section for adjustment. Adjustment using notched nut. Adjustment by differential screw action. Self-compensating device. Adjustment actuated by wrench. Set screw device. Device using rotating spacer block. Another flexing device. Radially contracting nut on screw. Method of clamping nut on screw. Split nut with radial base. Automatic device. Half-nut devices.

Mounting Chucks, by F. Horner. (*The Machinist, Vol. 83, No. 31, 9 September, 1939, p. 412E, figs. 12*).

Threaded spindle ends for small and medium size. Spigot support and large shoulder. Adapters to flanged spindle. Location is obtained from the flange diameter, or a recess in the bore, while a spigot is often added, especially for large lathes, to sustain the overhang. The Ward recessed flanged spindle end, which has six holes so pitched that either three- or four-jaw chucks can be secured, and there are also two holes diametrically opposite to take socket push-off screws. Tapered nose for bench lathe spindle. Cam-lock bolt design. Flanged and taper spindle nose. Quick-release attachment. Long taper and key mounting. Spindle with integral centre and driver. Adjustable hood for setting adapters.

Machine Shop Patents. (*Machinery, Vol. 54, No. 1403, 31 August, 1939, p. 697, figs. 2*).

Sectional view of backlash-eliminating table drive mechanism for a milling machine. The hydraulic circuit used with the backlash-free drive. No 508,269, Alfred Herbert, Ltd., A. H. Lloyd, and G. E. Leech, all of Canal Road, Edgwick, Coventry. (Application date, September 22, 1938. Published July 27, 1939).

MACHINE TOOLS.

Driving Power of Lathe Chucks. (*Machinery, Vol. 54, No. 1402, 24 August, 1939, p. 657, figs. 3*).

Chuck efficiency varies considerably in different types, being very low where the jaws are screw or scroll actuated, and higher where they are actuated by an air-cylinder and piston. A considerable loss takes place in all types as a result of the friction of the jaws in their guides in the body. To facilitate comparisons between different chucks and to simplify calculations, a jaw is assumed to exert a pressure of 1 lb. on the work in each of the illustrations. Examples : (1) A screw-operated three-jaw independent chuck. Proposal to increase the efficiency of the chuck. (2) A three-jaw universal chuck in which the jaws are actuated by a continuous scroll. (3) A three-jaw universal chuck, in which the jaws are actuated by three separate but similar scroll grooves cut in the face of one plate. (4) A three-jaw universal chuck in which the jaws are actuated by compressed air through the medium of a piston in a cylinder, and bell-crank levers.

Recent Developments in Internal Grinding Machines. (*Machinery Lloyd, Vol. XI, No. 17, August 26, 1939, p. 19, figs. 14*).

A considerable amount of work which previously could not be attempted on automatic sizing internal grinders, is now being handled with the utmost efficiency and at production rates which cannot be obtained on other types of internal grinding machines. The great majority of holes in high production are short in length relative to their diameters, and often such holes are of the blind or shouldered type. The grinding wheel is of a width approximately equal to the length of hole being ground. The principle of plunge cut grinding is now used in internal grinding. The cross-feed of the wheel is entirely independent of any traverse or movement of the work. In order to obtain a constantly diminishing feed, the cross-feed is operated through a cam mechanism. Cross feed time cycle. The wheel is trued automatically between the insertion of each piece of work. Combined hole and face grinding. Means are provided for trueing the end face of the wheel to preserve a constant depth in the recess. For combined hole and external face grinding operation, a double spindle set-up can be supplied on the machine.

Die Design and Construction, by C.R.C. (*Machinery, Vol. 54, No. 1405, September 14, 1939, p. 729, figs. 7*).

Reference is made to the construction of the upper member or blanking die, the die adapter, standard punch retainers, inside strippers, springs, and spring guards. Typical interchangeable piercing punches with retainers. Solid-type punches with and without flanges. Retainer-type punches inserted in a soft steel retainer plate. Sectional drawings showing a die mounted on an adapter. Diagram illustrating the "Timing" of blanking and piercing

operations. Two different arrangements of standard punch retainers. Die designs making use of knock-out plates having single pins. A typical application of an internal-type knock-out plate. Guards made of sheet metal are used to enclose springs and are fastened to the die shoe.

MANUFACTURING.

Motor-car Rear Axle Design and Production, by G. W. H. Hash. (*Machinery, Vol. 54, No. 1402, August 24, 1939, p. 653, figs. 8*).

Methods of heat-treating the gears and assembling the finished parts. The gear steel. Forging methods. Annealing after forging. A tank for quenching bevel pinions. Heat treatment of gears and pinions. The Pack-carburizing method. Gas-carburizing methods. The method of assembly and checking varies somewhat with the type of mounting and housing. Designs using tapered roller bearings with shim adjustments present unusual problems in manufacture and assembly because of the necessity of properly preloading the bearing in addition to positioning the gear and pinion.

Machining the German 4-in. Shell. (*Machinery, Vol. 54, No. 1404, September, 1939, p. 705, figs. 11*).

Operation layout showing the sequence of processes in the machining of a 4-in. shell. Tool layout for the first turning operation on the trench mortar shell stamping. Arrangement for machining the head of the shell after bottling. Tool layout for machining the base end of the trench mortar shell. Arrangement for form-turning and grooving the shell.

Oberflæchenveredlung durch Feinstfræsen (*Fine surface finishing by milling*), by Willy Gross. (*Werkstattstechnik und Werkleiter, Vol. XXXIII, No. 16, August 15, 1939, p. 393, figs. 13*).

The useful tool is the cutter head with inserted blades. Examples : 7 in. diameter and 10 blades ; 8 in. diameter and 12 blades ; 10 in. diameter and 16 blades ; 16 in. diameter and 20 blades. The best working conditions are on the plain horizontal slab milling machine with its rigidly founded bed and safely guided table. By zig-zag ribs and box shape beds, well and regularly supported, the uprights are very rigid and yet not heavy. They are very resistant to bending actions and vibration. Examples of well ribbed bed and strut design and spindle drive. Microscopic pictures of the profile of a ground and of a fine-milled surface. The deviations of heights are : for the ground surface between 4μ and 6μ ; for the milled surface between 2μ and 3μ (1μ = 0,001 mm. = 0.00004 in.). Very fined lapped cutting edges without any bur, a tight fit on the spindle nose and full concentricity of the cutting blades are indispensable. All blades must cut uniformly.

Riveting Methods in Aircraft Construction. (*Machinery, Vol. 54, No. 1405, September 14, 1939, p. 733, figs. 7*).

Diagrams showing : (1) Stages in the pin-riveting operation. (2) In the punch-riveting operation. Heinkel machine employed for the pin-riveting process.

MATERIALS, MATERIAL TESTING.

The Resistance to Relaxation of Materials at High Temperature, by Ernest L. Robinson. (*Transactions of the A.S.& E. for August, 1939, Vol. 61, No. 6, p. 543, figs. 26*).

Relaxation tests at high temperature give direct information on the permanent tightness of bolted joints and shrinking assemblies. They also give direct measurements of the effectiveness of strain-relief anneals. Indirectly they give, in relatively short time and small furnace space, reliable information on long-time constant-stress behaviour although direct computation of either type of performance from the other is uncertain. In relaxation tests, total strain is definitely limited, whereas, creep rates based on constant-stress tests may, but do not necessarily, correspond to excessive amounts of strain, thus giving too optimistic indications of strength. Although advantageous, relaxation tests do not take the place of constant-stress tests. A simple formulation for relaxation is given which holds good for considerable periods although rather sudden changes of trend suggest the possibility of physical changes in the material which are easily predictable in advance. Test results are given on six materials at various temperatures.

Les materiaux pour les couples a vis sans fin (*The material for worm drives*), by C. H. Bierbaum. (*La Machine Moderne, Vol. 33, No. 374, August, 1939, p. 575, figs. 9*).

Practical tests on the materials for worm drives presented at the annual meeting of the American Society of Gear Manufacturers. The ordinary type of worm itself used in such gearing. Result of case-hardening on the worm. Examples of complete drives with an unusual endurance. The steels used for the worm hardened to the core. Results of trials made with case-hardened and nitrided worms. Modern hardening processes.

Flexible Ebonite. (*Neoprene News, No. 7, p. 6*).

Ebonite is the technical name for vulcanite. Neoprene makes flexible shock-proof ebonite.

MEASURING METHODS.

Theory and Design of Balancing Machines. (*Machinery Lloyd, Vol. XI No. 18, September 9, 1939, p. 19, figs. 17*).

Theory of unbalance. In the modern balancing technique we have to distinguish so-called static and dynamic unbalances. In practice the most common out-of-balance which results from these various imperfections, is the combined static and dynamic unbalance. There are cases in which a clear distinction is to be made between the so-called internal and external balance. Every fast revolving part should be perfectly balanced on an up-to-date balancing machine. Constructional principles of modern balancing machines. Measuring on resonance principle. Exact direction of unbalance. The angle of lag. It may be stated that the most reliable balancing method is to employ actual counter-weights which are subjected to the same lag as the weights compensating the unbalance, and the exact position of the inherent unbalance is found from the actual portion of these counter-weights.

ORGANISATION, MANAGEMENT.

Production Research in Its Application to the Machine Shop of a Dockyard, by G. Schlesinger. (*Engineering, Vol. 148, No. 3845, September 22, 1939, p. 341, figs. 3*).

The author was entrusted with the task of reorganising the machine shop of the Wilton Fijenoord shipyard at Rotterdam-Schiedam in 1936 and of raising their output by a considerable percentage. It was uneconomic to replace all the old machines ; machines which were not adaptable were gradually eliminated, whilst those capable of having their speed doubled and of working to precision limits, were rebuilt. All hand-grinding machines were removed from the shop and collected in a central grinding department, and the number of materials was reduced from 50 to 14 machining groups. For each group the tool angle, size and shape of tip and shank, and the tool steel to be used were fixed so that the optimum output coincides with the minimum cost of materials and repairs. To ensure that the instructions given by the rate-fixer are followed by the workmen, an engineer continuously inspects the work produced. A form was drawn up, and is reproduced, giving all the data required by the operator for carrying out the rate-fixer's instructions.

History of Scientific Management in America. (*Mechanical Engineering, Vol. 61, No. 9, September, 1939, p. 671*).

Scientific management in America is one of the most potent factors in the industrial development leading to low production costs and a higher standard of living. As a historical and practical development, scientific management is the utilisation of policies and methods derived from analysis of all of the facts which bear upon a managerial situation. It involves research for the factual determination of policies and methods, standardization of the requisite practices, control of the procedures involved in the use of standards and co-operation of all individuals associated with the activity. First scientific management in industrial plant, through the initiative of Frederick W. Taylor. Unit time study. Rounding off the technique : The invention of the decimal dial stop watch, the working out of the shop slide rules, the development of production control, and the means for maintaining quality production. These were fairly well rounded off by 1905. The progress of development may be presented roughly in ten-year periods : (1) 1875-1885.—A groping for better methods of management, and the beginning of scientific management. (2) 1885-1895.—Development of the fundamentals of scientific shop management. (3) 1895-1905.—Rounding off the basic technique. (4) 1905-1915.—Expositions of scientific management to the world. (5) 1915-1925.—Collateral development by inrushing converts of rigid " efficiency " schemes and certain over-systematization with loss of due perspective and disregard for analytic studies. (6) 1925-1935.—Normal and sound development in the shop and acceptance by trade unions.

PLASTIC MATERIAL.

Plastics in America, by Herbert Chase. (*Aircraft Production, Vol. I, No. 11, September, 1939, p. 371, figs. 4*).

Developments in the use of synthetic materials for aircraft : Duramold for primary structures. " Duramold " possesses a specific gravity ranging from 0.5 to 0.9. The material is stated to be sufficiently non-hygroscopic and free from attack by fungi or moulds or other kinds of deterioration. An

aircraft moulded by the Clark Corporation as one complete unit. Resistance to fatigue—based on permissible stress—for equal weight per unit area is stated to be 50% better with Duramold than with 17ST Duralumin. The specific tenacity of Class I Duramold is about the same as that of 202,000 lb. steel. Duramold will not support combustion and, for a given weight per unit of shell, will support loads after a fire many times better than Duralumin. It is not subject to corrosion, and its energy absorbing characteristics are excellent. Damping of vibration is about five times better than that of metal. Finished external surfaces are smooth, and calculations based on wind tunnel tests at fairly high Reynold's number indicate that for a high-speed aeroplane having fuselage, wings and fixed tail unit of Duramold, some 25% less power will be required to attain a given speed than for an all-metal aeroplane with projecting rivet-heads, lap joints and the inevitable waves and wrinkles which are present in flight and/or after service in an all-metal aeroplane. Tooling costs. Transparent resin sheeting.

Education in Plastics, City and Guilds of London Institute Examination, 1939. (*British Plastics and Moulded Products Trader, Vol. II, No. 124, September, 1939, p. 184, figs. 6*).

First paper contains the most important questions put during the examination. Preparation and uses of one of the following plastic materials : (i) Casein. (ii) Nitro-cellulose. (iii) Urea-formaldehyde moulding powders. Account of two of the principal methods of testing the flow of moulding materials. Account of the standard method of testing : (i) Surface resistivity. (ii) Electric strength. Account of the chief principles governing the design of injection moulds for moulding thermo-plastic materials. The different types of pins in use to produce moulded-in screw threads in a compression moulding, with particular reference to the method of location in different parts of the mould. Account of : (i) Acetone resins. (ii) Alkyd resins. (iii) Bonding of plywood with synthetic resins. (iv) Coumarone resins. (v) Lignin resins. (vi) Oil-soluble synthetic resins. (vii) Polyethylene resins. (viii) Power factor (ix) Soya bean plastics. (x) Sulphonamide resins. Second paper: Mould design.

SMALL TOOLS.

The Design of Boring Bars, by P.G. (*Machinery, Vol. 54, No. 1406, September 21, 1939, p. 753, figs. 14*).

For the production of high precision holes with a very smooth finish, special tools with inserted tips are necessary. Precision radial adjustment must be provided for the tool, together with means for rigidly clamping it after adjustment. Whereas the design of relatively large boring bars above 1 in. diameter presents no great difficulty, small boring bars, especially those below ½ in. are by no means easy to design and construct. Examples : Distinction can be drawn between the following methods of carrying out the operation on special fine boring machines, lathes, and machines adapted for the purpose such as internal grinding machines. (*a*) Rotating workpiece. (*b*) Rotating boring bar. (1) Between dead centres. (2) Overhung. (3) Piloted. Illustrations : Machining a rotating workpiece with a stationary boring bar. Boring bar rotating between fixed centres. Rotating overhung boring bar gripped in the machine spindle. Boring bar having both axial and rotary feed movements. Incorrect design for screw clamping. Axially disposed clamping screw with pad between screw end and shank. Method of clamping by means

of a screw actuated wedge. Method of clamping by means of an eccentric. Method of clamping by means of a pad block : (*a*) Concentric ; (*b*) eccentric. Collar type holder clamped by means of socket screws and pads. Split collar-type holder with screw clamping. Tool shank clamped in collar-type holder by means of a socket screw and pad. Tool shank clamped in collar-type by means of a slit and screw. Tool shank clamped in collar-type holder by means of a pad block. Clamping with the aid of screws only cannot be recommended. A small pad of soft steel or copper should always be introduced between the tool shank and the screw.

S.K.F. Ground Thread Taps. (*Machine-Tool Review, Vol. 27, No. 170. May-June, 1939, p. 331, figs. 8*).

In cutting a good class thread pitch, angle, form of thread and accuracy of effective diameter are of first importance. This requirement can be met efficiently by using ground thread taps. The pitch error is guaranteed not to exceed .0002 in. in a length of 1 in. of thread. The threads are relieved from the cutting edge so that sticking in the hole is eliminated, and the relief is so arranged that the tap is never reduced below its nominal diameter by re-sharpening. The cost of a tap should be judged on cost per tapped hole. Some actual examples may be quoted : Using good quality unground taps 1,500 to 2,000 holes per tap were threaded in steel window frames. When replaced by ground thread taps production was increased to 18,000 holes per tap, and the threads were greatly improved. One-eighth inch gas taps averaged 1,200 holes, $\frac{1}{2}$ in. deep in 3% nickel steel, taper and plug taps being used. One well ground tap produced 3,000 holes. Lubricants play an important part in the success of tapping operations. The choice of lubricant should be decided according to the material being tapped. It is always advisable to re-sharpen taps as soon as they show signs of wear. Positive mechanical control ensures true lead, correct angular relation of flutes with consistent lands and front rake.

Mandrins pince-barre de tours revolver (Collets & Chucks to Clamp the Bars in Turret Lathes). (*Report*). (*La Machine Moderne Vol. XXXIII, No. 374, August, 1939, p. 576, figs. 14*).

The design of chucks and collets, their function and the use of clamping collets with taper jaws. Collets with backward taper. Chucks with double toggle-levers. Bar chucks without longitudinal backward motion. Pneumatically operated bar chucks without retreat. Taper collets and jaws. Special features of spring collets. Main collets with interchangeably inserted jaws. Table of dimensions of taper jaws for toggle chucks.

SURFACE TREATMENT.

The Value of Oxide Films on Aluminium and Its Alloys (*Mechanical World and Engineering Record, Vol. CVI, No. 2747, August 25, 1939, p. 171, figs. 2*).

During the last few years the application of anodised aluminium has progressed steadily in certain quarters, but there still exists a large untouched field, due mainly to ignorance of the purpose of the anodic film and to unjustified fears that the process is a difficult one to install or manage. The present article reviews the processes available and summarises the useful properties of oxidised aluminium.

Combating Corrosion. (*Machine-Tool Review, Vol. 27, No. 171, July-August 1939, p. 359, figs. 2*).

The " Herbert " test simulates under controlled conditions, the circumstances which affect cast-iron lathe beds during the machining of steel, brass or other metals with a soluble oil emulsion as the coolant fluid. Blocks of close-grained cast-iron, 4 in. × 4 in. × ¼ in. thick are used, which are similar in composition to lathe bed metal. The block is supported horizontally on a table in a room away from acidic fumes. About a teaspoonful of clean oil-free drillings is placed on the surface or, if steel is not appropriate, dry chips from any other metal which is being machined may be used. Next a teaspoonful of the cutting emulsion to be tested is poured carefully over the drillings and is allowed to stand for twenty-four hours. A thoroughly satisfactory grade will make no appreciable attack.

Surface Roughness and Wing Drag, by Manley J. Hood. (*Aircraft Engineering, Vol. XI, No. 127, September, 1939, p. 342, figs. 8*).

During the past eight or ten years the speeds of most types of aeroplanes have been practically doubled. The stage has now been reached where it is necessary to consider the effects on drag of such items as rivets, sheet-metal joints and other irregularities on the surfaces exposed to air flow. Rivets and their influence. Manufacturing Irregularities. The tests showed that a small degree of surface roughness will cause a serious increase in drag. In connection with permissible roughness, it is of practical interest to note that, when the painted surface of the aerofoil was sandpapered with No. 400 water sandpaper, the drag was as low as when the surface was highly polished. For aeroplane wings to have the smallest possible drag, they must be smooth, but need not be highly polished. Application of results. The magnitude of the effect of rivets and lapped joints on the wing of a large aeroplane is illustrated by an example. A graph shows for every chord position, the excess power required just to overcome the drag caused by the rivets and lapped joints behind that position. With all the rivets and laps of a certain type over 500 excess horse power is required. If, as is generally attempted at present, the irregularities are eliminated from the forward 25% of the wing, 180 h.p. is still required to pull the remaining rivet heads and lapped joints through the air.

TECHNICAL INFORMATION.

Overseas Trade in Machine Tools. (*Machinery, Vol. 54, No. 1402, August, 24, 1939, p. 652*).

During 1939 there has been a marked upward movement, and for the first seven months imports amounted to no less than £3,896,897. The bulk of imports, which in July alone amounted to £747,763, are required either directly or indirectly for armament purposes. During the past three and a half years, imports have aggregated £18,673,201. Exports remained fairly steady in 1935, 1936, and 1937, the respective totals being £2,246,497, £2,013,606, and £2,151,593. In 1938 there was an increase to £4,476,436, and this year the level has been even higher, the total for the first seven months being £3,227,747. This rise has been largely accounted for by the greater requirements of the Soviet Union. There is no doubt that the productive capacity of the machine-tool industry has been substantially expanded.

WELDING, BRAZING.

High-speed Spot Welding, by H. W. Roth. (*The Machinist, Vol. 83, No. 29, August 26, 1939, p. 565*).

These methods may be described by the general term " multiple spot welding," and divided into two different groups : (1) Simultaneous spot welding, and (2) successive multiple spot welding. The first group offers the advantages of definite time saving with the disadvantage, however, of considerably increased transformer capacity. Another disadvantage of the " simultaneous" method is the difficulty of uniform current distribution to the individual spot welds. The most satisfactory results may be obtained by using two individual transformers with the primary coils in series or parallel and the secondaries in parallel. Successive multiple spot welding performs several spot welds in succession. The main advantage of this method was the fact that only a small transformer capacity was required regardless of the total number of welds, as only one weld was performed at a time. It is obvious, however, that the total welding time was in direct proportion to the number of welds. Successive spot welding shows a poor cycle efficiency, but it requires only small transformer capacity and allows a more uniform distribution. Combining features of both methods, " Ultra-Speed " spot welders incorporate a multitude of individual electrodes, insulated from each other, which are put under pressure simultaneously. It has been possible to design a commutator unit which safely operates at a speed from 8 to 20 spots per second, depending upon the metal thickness to be welded, and a maximum current of about 40,000 amp. can be controlled.

Les Recents Perfectionnements dans la Construction Soudee des Machine-Outils (*Recent improvement in design and manufacture of welded (fabricated) machine-tool components*), by L. F. Nenninger and W. A. Maddox. (*La, Machine Moderne, No. 373, July, 1939, p. 511, figs. 20*).

Rigidity of machine-tools. Stands and up-rights of cast iron age and lose their internal tension even under normal conditions of use ; between force and deformation there is no proportion. With steel the relation of deformation to tension is proportional within the elastic limit. In a fabricated design it may occur that the tension becomes so great that the zone of elasticity is crossed and that the deformations remain permanent. By a series of tests the important result has been found that by heating a fabricated stand and using a correct cycle of heating and cooling up to 650°C. and by maintaining the temperature for an hour usually for 1 in. thickness of wall, the remaining internal tensions are smaller than 2 Kg/mm^2 (1.5 to/sq. in.). Precious qualities of cast ron : Its resistance is superabundant for the majority of machine tool designs. It has a great damping capacity to absorb vibrations which no other metal has. The designer of fabricated machine-tools must include in this new kind of design all essential qualities of the cast iron construction. The exterior aspect of the machines is very important, but opinions change with the years. We must find the new style for the welded (fabricated) design. Some examples are shown : (1) *Grinding Machines* : (2) *Milling Machines*: For milling machines the question of vibration and trepidation is very important, in particular with cutter head and inserted blades which machine interrupted surfaces. (3) *Broaching Machines* with hydraulic drive. The development of fabricated components is supported by the general rise in the price of cast pieces. The price of the patterns is prohibitive for many important constructions which are made in one or two pieces. The delay in delivering a bed or upright in welded steel is from two to four weeks less than for a piece finished in the foundry. The future development of fabricated design depends on two

elements : (1) Greater or lesser adaptation of cast iron to the qualities of steel from the mechanical point of view in each particular case, and (2) the price of cast iron and steel from the point of view of the design.

Welding Aluminium, by H. Hinxman. (*Sheet Metal Industries, Vol. 13, No. 149, September, 1939, p. 1173, figs. 4*).

Recent improvements in the technique of resistance welding have provided a method of jointing aluminium and its alloys which has received the approval not only of many commercial users, but also of the majority of aircraft builders. The article explains how the initial difficulties of this type of welding process have been overcome, and how, under suitable conditions, welds can be obtained which fulfil the most exacting requirements. Example : Aircraft cowling on which riveting has been almost eliminated. Types of machines. Surface preparation. Electrodes. Pressure and current values. Alloys : High-power spot-welding machine operated in conjunction with Thyratron control equipment. Strength of welds.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, CASEHARDENING.

Machines for Surface Hardening by the Shorter Process. (*Industrial Gases, June, 1939, pp. 61-70, 19 figs.*).

The success of the shorter process depends upon strict control of the extent and duration of heating and quenching, by means of suitable mechanical devices. These are classified, according to the relative movement between burner, quench, and job, into four classes. A typical machine in each class is described, showing how the fundamentals of each process have been carried out in respect of different classes of work. The machines described include the Shorter water-cooled blow-pipe, the heavy-duty blow-pipe, the ring burner blow-pipe, the Shorter gear hardening machine, the Shorter-Griesogen automatic gear hardening machine, and the Gleason gear-hardening machine.

JIGS AND FIXTURES.

Fabrication Technique on Jigs and Fixtures, by V. N. Scott. (*Machinery, October 12, 1939, Vol. 55, No. 1409, p. 30, 5 figs.*).

The layout of the jig or fixture is first made without any reference to arc welding. The designer then makes a separate sketch which indicates how the welding is to be done. Usually, only one fixture of a particular design is required. Diagrams showing various forms of welded joints employed in the fabrication of jigs and fixtures. In the case of a fabricated jig or fixture, the machining allowance is $\frac{1}{4}$ in. or less, except for very large work, when an allowance of $\frac{1}{2}$ in. is made. In general, welded jigs cost about 25% less than similar jigs produced by conventional methods. As time is a very important factor in connection with jigs and fixtures, it is advisable to handle the welding work in the tool room. Before final machining, all strains should be removed by normalising or annealing. This can be done by heating in the furnace to 1,300°F. and allowing the work to cool in air.

LIGHTING.

Factory and Workshop Lighting under War Conditions, by S. J. Patmore. (*Industrial Welfare and Personnel Management, October, 1939, Vol. XXI, No. 251, p. 387, 4 figs.*).

Legal requirements. Glass roofs and safety. Lighting standards. Accidents and lighting. Diagrammatic table of comparison of light output and energy consumption between tungsten filament gasfilled and H.P.M.V. electric discharge lamps. Electrical discharge lamps. Glare. Acclimatisation to darkness.

MACHINE COMPONENTS.

The Spring Clutch, by C. F. Wiebusch. (*Journal of Applied Mechanics, September, 1939, Vol. 6, No. 3, p. A-103, 9 figs.*).

The matematical theory is developed for the spring clutch which consists of two co-axial cylinders placed end to end and coupled torsionally by a coil

spring fitted over them. Relations are derived whereby it is possible to design spring clutches in terms of the requirements and the constants of the spring material. Experimental verification of the relations is given. The theory of residual and active stresses as applied to the springs is discussed.

Deflection of Helical Springs under Transverse Loadings, by W. E. Burdick, F. S. Chaplin, and W. L. Sheppard. (*Transactions of the A.S.M.E. for October, 1939, Vol. 61, No. 7, p. 623, 13 figs.*).

An analytical approach to the problem of the transverse deflection of a helical closely coiled spring under the action of a force perpendicular to its axis and an end moment. Supporting test data are included to substantiate the formulas within established limits. Expressions for the stresses under this loading in combinations with an axial force are derived for the critical points on the spring.

MANUFACTURING.

Machine Forging of Shells. (*Machinery, October 12, 1939, Vol. 55, No. 1409, p. 25, 8 figs.*).

Developments in connection with the upset forging of shell bodies. Dies and tools for producing 5 in. shell forgings on an Ajax machine. Data relating to the forging of 75 mm. and 5 in. shells. Tool layout for producing 40 mm. shell forgings on a National forging machine. Stages in the production of the 40 mm. shell body. Tool layout for producing the nose-bush forging for a 40 mm. shell on a National forging machine.

Shell Manufacture in America. (*Machinery, October 5, 1939, Vol. 55, No. 1408, 10 figs.*).

Manufacturing divisions of the ordance department of Frankford Arsenal, Philadelphia, Pa., for the production, firstly, of ammunition for small arms, such as pistols, rifles, and machine guns. Secondly, of shells and cases for artillery projectiles, and thirdly of fire-control instruments. Methods employed for loading and locating a 75 mm. shell at the first and second stations. Tool layout for machining a 75 mm. shell on an eight-spindle bullard mult-au-matic.

Producing the Potez *63,* by Maurice A. Smith. (*Aircraft Production, October, 1939, Vol. 1, No. 12, p. 412, 29 figs.*, and *November, 1939, No. 13, p. 439, 29 figs.*).

Part I : Layout of the works, design methods, the wing spars, jigs for the main wings. The Potez 63 is a twin-engined low-wing cantilever monoplane with a retractable undercarriage which folds rearwards into the engine nacelle fairings. Twin fins and rudders are attached to the tailplane, which has a pronounced dihedral. The construction is entirely in metal, with flush-riveted stressed skin-covering. Part II : The centre section and its jigs, nose units, general assembly, equipment and test.

Wooden Airscrew Blades, by J. A. Oates. (*Aircraft Production, October, 1939, Vol. 1, No. 12, p. 422, 15 figs.*).

Modern production of blades for variable-pitch airscrews, extreme care in selection and conditioning of the wood, Schwarz and Rayoid processes.

The German Way. (*Aircraft Engineering, October, 1939, Vol. XI, No. 128, p. 373*).

An issue devoted largely to enemy methods and technique. The way in which, for the present moment, we can best serve the cause of Allied aviation

is by publishing as much material as we can obtain on German design and methods of production. The German way. Some German military types.

Henschel Theories on Production. (*Aircraft Engineering, October, 1939, Vol. XI, No. 128, p. 395, 12 figs.*).

Some notes on the methods advocated by a well known German engineering firm (Henschel) which is a comparative newcomer to the aviation industry

MATERIALS, MATERIAL TESTING.

Diamond Hardness Tester. (*Mechanical Engineering, U.S.A., October, 1939, Vol. 61, No. 10, p. 573, 1 fig.*).

National bureau of standards. A sensitive pyramidal-diamond tool for indentation measurements.

X-ray Testing of Welds, by H. Hirst. (*The Commonwealth Engineer, August 1, 1939, Vol. 27, No. 1, p. 3, 6 figs.*).

Technique described for detection of faults in all types, applicable to large construction jobs.

MEASURING METHODS.

Formulae and Tables for Determining the Developed Length of Bends, by T. P. H. and S. C. D. (*Machinery, October 26, 1939, Vol. 55, No. 1411, p. 81, 4 figs.*).

Diagrams illustrating the methods employed for calculating the lengths of material required for parts which are to be produced by bending. Formulae for determining the length of stock for bending apply to metal parts made from ferrous and non-ferrous material bent on simple tools or on the bench, where the limits specified are $\pm \frac{1}{64}$ in. Bent parts illustrating the application of the formulae and tables for finding developed lengths.

Hard to Machine ? by Herbert A. Reece. (*The Machinist, October 7, 1939, Vol. 83, No. 35, p. 676, 4 figs.*).

A standard drill press arranged with automatic feed is equipped with a device for measuring thrust pressures to determine machinability ratings of different materials. The thrust head consists of two telescoping cylinders held apart by an accurately calibrated spring. They are joined by sliding keys so as to rotate the drill. Springs of differing characteristics can be used, as readings for depth of spring compression are translated into pounds of thrust pressure by charts similar to this. Each spring is recalibrated frequently to insure consistent results.

A Laboratory Test for Machinability, by A. S. Kenneford. (*Engineering, October 27, 1939, Vol. 148, No. 3850, p. 485, 6 figs.*).

A metal which is said to be easily machinable is one which can be machined at high speed, while giving a good surface and long tool life. Oxford and Airey use a machine which can be used for determining the work done in removing a given volume of material from a test piece and, although the method takes no account of other factors such as surface finish and tool life, it does give rapid quantitative measurements on which an index of machinability may be based. The results of some experiments carried out in the research department, Woolwich, used an Oxford-Airey machine. Tests were made on series of alloys, varying from those said to be easily machinable, e.g. magnesium alloys, " free-cutting " aluminium alloy, and leaded brass,

to those machinable only with difficulty, such as Monel metal. Experimental procedure. Effect of variations in feed and depth of cut. Distances travelled by tip of tool when making a cut. Order of machinability on basis of work done per cubic inch of metal removed for all metals tested. The effect of lead additions on the machinability of 70 : 30 and 60 : 40 brass. Directional machinability due to inclusions. Effect of increasing the carbon content of a steel.

X-ray as a Production Tool. (C. T. Barnett, *Steel, August 28, 1939, p. 38, 11 figs.*).

Description of a portable 400,000 volt X-ray machine and the use of penetrameters. A set of examples of exographs shows a typical bad weld, and a description of the technique used to obtain them is given. The use of fluorescent screens intensifies the exograph negative and result in a considerable saving in exposure time. The author considers that as knowledge of radiography is gained by those concerned so will X-ray apparatus become more generally used as a production tool.

MECHANICS.

Hydraulic Circuits, by Albert H. Dall. (*The Machinist, October 7, 1939, Vol. 83, No. 35, p. 4467 E, figs,*).

Hydraulic feed rate control systems can be divided into two types : (1) throttle type circuit ; (2) variable delivery pump circuit. Diagrams showing feed circuit with constant delivery pump and throttle valve ; circuit with constant delivery pump and a throttle valve in back pressure line, variable displacement pump circuit, variable displacement pump circuit with leakage make-up pump, variable displacement pump closed circuit with booster pump, locked circuit with differential relief valve (Cincinnati patent), forward and back pressures plotted against work resistance.

PHYSICS.

Vibration Problems—Part II, by J. Ormondroyd. (*Journal of Applied Mechanics, September, 1939, Vol. 6, No. 3, p. A-127*).

Dynamic specifications. Mass. Moments of inertia. Spring constants. Damping constants. Coulomb friction. Internal friction in solids. Viscous friction. Impactive damping.

Boundary Friction in Bearings at Low Loads, by L. M. Tichvinsky and E. G. Fischer. (*Jouranl of Applied Mechanics, September, 1939, Vol. 6, No. 3, p. A-109, 16 figs.*).

Bearing tests performed in the region of semi-fluid or boundary lubrication. Bearings 2½ in. in diameter mounted in a rigid housing were loaded lightly and their performance studied in an attempt to correlate it with various physical properties of the bearing and journal materials. In this connection special consideration was given to journal surface finish and its measurement.

PLASTIC MATERIAL.

Plastics and their Applications, by James Taylor. (*Aircraft Production, October, 1939, Vol. 1, No. 12, p. 407*).

Two main types. (1) Thermo-plastic materials ; (2) thermo-setting materials. Thermo-plastic materials are those which under the action of heat, and perhaps pressure, soften and which, on subsequent cooling, become hard again. Thermo-setting materials are those which under the influence of heat,

and perhaps pressure, soften or become plastic, and which on continued application of this heat and pressure become hard again and set definitely. Ten headings over the main types : (*a*) Bitumen ; (*b*) cellulose nitrate (celluloid) ; (*c*) casein ; (*d*) cellulose acetate, etc. ; (*e*) phenolformaldehyde ; (*f*) ureaformaldehyde (or amino plastics) ; (*g*) glyptals ; (*h*) polystyrols ; (*i*) polyvinyls ; (*j*) methyl-methacrylate. Application to airscrews and in the construction of various flights and navigation instruments, in distributor heads, magnetos, switches, radio components, and in terminal sleeves. Availability.

RETAILING.

The Separation of Aluminium from Scrap Metals, by D. C. Downie. (*Aluminium and the Non-Ferrous Review, September, 1939, Vol. 4, No. 10, p. 318*).

The method consists of acquiring solutions of high specific gravity, and charging the mixed turnings into them, whereby the aluminium floats, and all heavier metals sink. " Lifting purposes." Apart from the alkalis and alkaline earth metals, there are what are regarded as the rarer alkaline earth metals, which remain unaffected by aluminium. Solutions of soluble salts of these are mixed to give the greatest density beyond that of aluminium, without requiring heating. The work of separation consists of simply charging the mixed turnings, borings, and chips into a large lead-lined cask, with perforated pan at the bottom. All aluminium, duralumin, etc., floats on the surface of the liquid like sawdust, and is collected by means of perforated ladles immersed in a washing vat, and transferred to the melting shop.

SMALL TOOLS.

The Design of Boring Bars, by P. G. (*Machinery, October 19, 1939, Vol. 55 No. 1410, p. 65, 14 figs.*).

Diagrams of (1) socket screw with fine thread for tool shank adjustment ; (2) fillister head screw for tool shank adjustment ; (3) ring nut with micrometer graduation for tool shank adjustment ; (4) use of a screw parallel to the shank axis for fine adjustment ; (5) arrangement giving fine adjustment by screw thread and rack teeth ; (6) differential screw adjustment ; (7) alternative method of adjustment using differential screw ; (8) method of arrangement by means of an axial wedge ; (9) method of wedge adjustment which avoids weakening of the tool shank ; (10) use of inclined serrations instead of wedges for adjustment ; (11) adjustment by inclined serrations on one side of the shank only ; (12) method of adjustment by means of a scroll engaging curved teeth ; (13) method of adjustment by means of a rotating member having an eccentric groove ; (14) method of adjusting the tool shank in a collar-type holder ; (15) alternative form of scroll adjustment for a tool in a collar-type holder.

Die Design and Construction, by C. R. C. (*Machinery, October 19, 1939, Vol. 55, No. 1410, p. 57, 7 figs.*).

General arrangement of a progressive-type blanking and piercing die. Gauges used in connection with progressive-type dies. Types of gauges to ensure accuracy. Diagrams illustrating the use of a spring slide gauge for finish gauging. Finish-gauging by means of a spring-operated V-block.

Drawing Die Troubles, by C. W. Hinman. (*The Machinist, October 14, 1939, Vol. 83, No. 36, p. 683, 7 figs.*).

Specific faults in shells are traced to incorrect punch and die radii, poor blank-holder action, or other circumstances causing wrinkles or cracks.

SURFACE TREATMENT.

Anodic Finishes for Sheet Aluminium Products, by E. G. West. (*Sheet Metal Industries, October, 1939, Vol. 13, No. 150, p. 1259*).

Properties and uses of anodic films. Composition and structure. Appearance. Resistance to corrosion. Mechanical strength. Colouring. Electrical resistance. Heat resistivity and reflection. Application of anodic films.

Temperature-indicating Paints. (*Aircraft Engineering, October, 1939, Vol. XI, No. 128, p. 385, 4 figs.*).

Recent advances made in Germany in developing stable paints for use at high temperatures.

Metal Spraying with Chromium Steel. (P. Leder, *Steel, July 31, 1939, p. 38, 2 figs.*).

Results obtained in the spraying of worn machine parts with chromium steels seem to indicate that high carbon, plain chromium rustless steel is superior in its wear resistance to simple carbon steel of the same sprayed hardness. Examples of such spraying and the savings effected thereby are cited.

Metal Spraying. (C. Cleveland, *Metal Industry, August, 1939, pp. 361-4, 9 figs.*).

First the developments are traced which have taken place in metal spraying during the last forty years, and some of the methods adopted are described. The modern method of metal spraying, introduced shortly after the use of oxygen and acetylene for welding, is then described, and the construction of recent metal spraying machines is discussed in detail. Finally, the advantages and disadvantages of the process are enumerated, together with the uses to which it can be put, and the various kinds of metals that can be used. Precautions are described which must be taken before a surface can be sprayed.

TECHNICAL INFORMATION.

Camouflage of Large Installations. (*The Factory Manager, October, 1939. Vol. VII, No. 10, p. 525, 4 figs.*).

General principles underlying the art and practice of camouflage and the need for collaboration between those responsible for neighbouring premise, which call for this treatment.

WELDING, BRAZING.

Automatic Arc Wdeling, by E. Rosenberg. (*Welder, August, 1939, p. 239, 5 figs.*).

After discussing methods of applying flux to the parts to be welded the author describes methods of automatic feed for the electrode such as by means of a small feeding motor, the armature of which is connected to the armature of a small D.C. control generator with differentially wound field coils. One coil is connected across the arc and the other is excited permanently from a constant voltage exciter. By suitably winding these coils, a change of arc voltage due to a change in length of arc causes the fields of these coils to become unbalanced hence feeding the electrode as required. Finally, a large tube welding machine is described and examples of methods used for various work are given.

Electric Arc Welding. (*The Welding Industry, October, 1939, Vol. VII No. 9, p. 328*).

A new list of approved electrodes for electric arc welding issued by the *British Corporation of Shipping and Aircraft*. The list gives the maker's name, name of electrode, distinguishing marks, etc., limitations in use.

Strip Welding. (**D. A. McArthur,** *Steel, August 28, 1939, p. 42, 1 fig.*).

The highest possible efficiency of handling operations is an essential requirement of modern strip welding lines. Description of modern procedure, equipment and methods. Comparisons are made between the relative times required for joining the ends of successive coils by stitching the ends, and flash welding, and some figures relating to these two methods are given. Problems with regard to alignment and location of the strips through the shears and welding machine are discussed and best feed speed is considered.

Welding Technique and Methods, by F. Clark. (*The Welding Industry, October, 1939, Vol. VII, No. 9, p. 333, 8 figs.*).

It is not generally appreciated that weld shrinkage across the top of a 90° vee is roughly seven times greater than across the bottom, and about four and a half times greater across a 60° vee. Hence a further reason for correct and uniform preparation. Heat conduction can be prevented from raising the metal temperature to an unsatisfactory degree by rapid withdrawal of that heat by cooling devices, such as immersion of the article in water by the application of water spray or by the contact of large masses of metal.

Fatigue Tests of Butt Welds in Structural Steel Plates, by W. M. Wilson and A. B. Wilder. (*The Welding Industry, October, 1939, Vol. VII, No. 9, p. 336, 1 fig.*).

Silicon-steel plates. Comparison of fatigue strength of butt welds in plates with fatigue strength of plates of riveted joints. Hardness survey of welds Carbon-steel plates. Microstructure of welds. Location of failure in test specimens. Types of fatigue failures. Conclusion from fatigue tests. Conclusions from metallurgical studies.

The Principles of Bronze Welding. (*Mechanical World, October 20, 1939, Vol. CVI, No. 2755, p. 362, 4 figs.*).

Details of procedure based upon the practice of the British Oxygen Co. Ltd. Bronze welded copper pipe joints. *A*—short bell butt joint. *B*—butt-tee joint. *C*—cup-tee joint. *D*—diminishing joint. *E*—straight weldable copper socket. *F*—four-way unequal branch weldable copper fitting. Angles of rod and blow-pipe for bronze welding of cast iron. Preparation and technique for two-operator vertical bronze-welding of cast iron. By the use of bronze welding for copper it is possible to carry out successful welds on non-deoxidised (tough pitch) material without difficulty. The welding of brasses and bronzes containing appreciable amounts of zinc involves a special technique. It is important that there should not be too great an excess of oxygen. A larger size nozzle may be required for brasses and bronzes than for steel. The preparation of the edges of the joint should be carried out as for steel. Both top and underside of the edges to be welded should be painted with the appropriate flux, previously mixed to a paste with water.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, HARDENING, TEMPERING.

Case Hardening, by E. G. Bishop. (*The Australasian Engineer, October 7, 1939, Vol. 39, No. 281, p. 13, 1 fig.*).

Case-hardening consists of two operations: (*a*) Carburising in order to increase the carbon content of the outer part of the steel, and (*b*) a subsequent heat treatment to refine the structure, harden the case, and to develop the roughness of the core. For special containers where the number of heats will be limited, welded and mild steel plates are satisfactory, but for continuous use heat-resisting alloy steels are to be recommended. Some firms use composite boxes made from sheet alloy steels with the bottoms cast on to them.

Sealing. A good method is the sand seal. A groove has to be made in the body and the lid fitted with a flange to project into the sand. As it is unnecessary to create a pressure to assist carburising, the use of the inverted containers where after packing the whole container is inverted, the weight will help to make a tight seal.

The carburiser. The function of the carburiser is to produce a rich carbon monoxide gas, from which the steel surface absorbs carbon. The size of charcoal grains must be small enough to be in intimate contact with the steel and large enough for the interstices to give enough space for the free circulation of the gas. One layer of charcoal grains between each part and the container is sufficient. The mixture used is six part of old carburiser to one part of new. After carburising the next step is the reheating, and during this operation it is easy to spoil the carburised steel. The most satisfactory method of reheating to overcome all difficulties of furnace atmospheres is the use of the sodium cyanide bath. If the best results are required the double heat treatment is necessary. Where warpage is to be avoided as much as possible, care in packing the container will be well rewarded. The old rule of heating uniformly applied equally to the carburising operation. Production case hardening. The continuous furnaces—long, tunnel-like structures in which the containers slowly pass in succession through heating, carburising, and cooling zones.

Effect of Plastic Deformation on the Age-hardening of Duralumin, by Robert W. Lindsey and John T. Norton. (*Aluminium and the Non-ferrous Review, October, 1939, Vol. 4, No. 11, page 348, 4 figs.*).

The experimental work consisted of a careful comparison of the behaviour of a single alloy of duralumin aged in the normal fashion, aged after cold-working, and cold-worked after normal ageing. Ageing was carried out at four different temperatures. The proofs used for the investigation were hardness, electrical resistivity, and X-ray diffraction measurements. Conclusions are drawn on: (1) Mechanical distortion of quenched samples; (2) mechanical distortion and spontaneous distortion; (3) some amount of incipient precipitation; (4) general precipitation in deformed samples; (5) deformation of aged samples.

COOLANT, LUBRICANT.

The Wedge-shaped Oil Film does the Trick, by John Haydock. (*The Machinist, November 11, 1939, Vol. 83, No. 40, p. 823, 5 figs.*).

Requirements for a precision grinding machine spindle : (1) An uninterrupted fluid film must be positively maintained between the spindle and bearing ; (2) the axis of rotation when running idle must be maintained in a constant position ; (3) change in position of spindle axis with change in grinding forces must be as small as possible ; (4) the bearing must be capable of supporting a load which varies in direction through a wide angle ; (5) frictional losses in the bearing should be substantially independent of applied load ; (6) bearing must be as foolproof as possible, with minimum wear, and must not require adjustment for varying grinding conditions such as finishing and roughing. Oscillograms of (1) old-style bearing—60 millionths vertical flutter, 25 millionths horizontal flutter ; (2) filmatic bearing—no discernable spindle flutter. The even alignment of wave tips in this oscillograph indicates a true running spindle. Cross-sectional view of the filmatic bearing shows the pressure interlock.

GEARING.

Self-locking Spur Gearing, by Paul Kohn. (*Machinery, November 16, 1939, Vol. 55, No. 1414, p. 175, 4 figs.*).

It is probably not generally known that self-locking can occur when spur gearing is geared up. Such an unusual effect may be produced when gear wheels run on shafts which are driven from other gears. Arrangement of a drive unit which has a self-locking action when used for gearing-up. Diagram illustrating method of determining the efficiency of the drive when used for gearing-down. Drive reconstructed for gearing-up. By the simple reconstruction of the drive considered, when gearing-up, the efficiency was increased from nil to 0.695 and, when gearing-down from 0.525 to 0.825.

HEATING.

Waterless Boilers, by John D. Watson. (*Industrial Power and Fuel Economist, October, 1939, Vol. XV, No. 169, p. 285, 1 fig.*).

Solving high temperature with low pressure process heat problems. The Dowthern boiler. In the field of waterless boilers, one using a mixture of 73.5% diphenyxolide and 25.5% diphenyl, commonly known as Dowtherm, is simple to construct, relatively cheap to install, and safe and economical in operation. A waterless boiler plant lay-out. This system is in operation at the well known American Bremo power station of the Virginia Public Services Co. It is stated to have proved a great success over some years, and to have given no trouble in handling the liquid through a standard economiser by means of two 200 g.p.m. cast steel pumps at 270 ft. head.

KINEMATICS.

High-speed Cam Design, by W. Richards. (*Machinery, November 2, 1939, Vol. 55, No. 1412, p. 105, 5 figs.*).

Displacement curve for high-speed cam. Displacement giving uniformly increasing acceleration and uniform retardation. Layout of cam profiles. Maximum pressure angle. Pressure angles may be varied, when conditions permit, by modifications to the cam base circle diameter. Acceleration, retardation, and velocity values are also adjustable, within limits, by choosing the displacement curve best suited to the conditions imposed.

MACHINE COMPONENTS.

Tightening of Bolts, by H. Dentler. (*Maschinenbau, Vol. 18, April, 1939 pp. 185-7*). (*English abstracts, Vol. 2, No. 7, July, 1939, pp. 94-5*).

The author describes an investigation into the security and uniformity of assembly of airscrews on aero-engine flanges. Five fitters with varied training and experience were selected, three types of nut and bolt were provided, and a number of spanners fitted with a lengthening-piece to afford extra leverage were rendered freely available. The men were instructed to pull up the nuts by their sense of feel and touch; the threads and nut-faces were oiled and greased. By a simple arrangement of a dial-gauge on the bolt-end, the extension and pull in the bolt were measured. The results are tabulated. The variation from the mean tension in the bolts attained 45% in one bolt. The author concludes that bolts and nuts involving risk to life cannot be safely left to the touch of the erector, and he recommends control by measurement of bolt-length.

The Design and Application of Friction Clutches—II, by P. G. (*Power Transmission, November, 1939, Vol. 8, No. 94, p. 579, 15 figs.*).

Survey of some typical examples of friction clutches, their characteristics and application. Multiple disc clutches. Hele-Shaw clutch. Platt multi dry-plate clutch. The Pullmore clutch. Conical disc clutches. Internal ring clutches. The Wigglesworth internal ring expanding clutch. Carter friction clutch. Super-Johnson friction clutch. Shell friction clutch. Bridge-Heywood clutch. Double screw-type clutch. External ring clutches. Mather & Platt external ring clutch. Combination of internal and external ring surfaces. Croft D/S rim-type friction clutch. Contraction band clutches. Cut-off contraction band clutch.

MACHINE TOOLS.

High-speed Light Vertical Milling Machines. (*Engineering, November 3, 1939, Vol. 148, No. 3851, p. 499, 4 figs.*).

The two vertical milling machines shown are manufactured by Messrs. George Gorton Machine Company, Racine, Wisconsin, U.S.A. The spindle of the Universal milling machine has a swivelling movement of 360 degrees in two planes at right angles and is capable of traverse relative to the width of the table. A motor running at 1,725 r.p.m. gives a range of from 600 r.p.m. to 2,700 r.p.m. The cutter spindle is carried in a sleeve and is mounted on precision ball-bearings, being thus supported at three points. The power feed, since it has an independent motor, is independent of the spindle speed. The vertical milling machine has spindle speeds up to 6,300 r.p.m. while speeds of as high as 12,000 r.p.m. are possible with special equipment. It is fitted with a lever-operated table for duplicating, the vertical spindle seen to the right of the main spindle being that carrying the tracer point. There are 12 longitudinal power feeds to the tables, the standard range being from 0.6 in. to 20 in. per minute.

Electric Equipment for Feeler-controlled Automatic Die-sinking Machines. (*Machinery, November 30, 1939, Vol. 55, No. 1416, p. 213, 8 figs.*).

Method of controlling the feed motors. Feeler with three built-in gauge heads for recording deflections in the horizontal, vertical, and axial directions. Diagram showing the connections for the relays and automatic switches used in conjunction with the feeler. Diagram illustrating the sinoidal control of the horizontal and in-feed motors. Circuit diagram for the horizontal feed

and in-feed motors on an automatic die-sinking machine. Diagrams showing how the feeler traces a sloping surface on the master. The resultant motion of the feeler tends to conform to the slope of the surface being traced. Stepless tracing of steep contours. Diagram showing the control arrangements when the feeler is used for automatic contour milling. Diagram showing how the feeler automatically traces the contour of a template. For contour-milling as well as for the die-sinking by successive traverse, either horizontally or vertically, the position of the control drum and regulator set, and therefore the direction of the resultant feed movement, is indicated by a remote-controlled instrument known as the " Eltascope."

Forming Shells by Drawing Metal both Upwards and Downwards, by M. J. G. (*Machinery, November 2, 1939, Vol. 55, No. 1412, p. 115, 4 figs.*).

When such work is encountered the problem arises of laying out dies that will produce shells without wrinkles or breakage. Lamp with metal base formed by means of the dies. Three stages in the production of the base for the lamp. Outline cross-section of the lamp base. Die used to blank and form shell. Second-operation die which forms the shell. The punch and die members of the forming die.

The Cookson Triangulation System—II, by W. Cookson. (*Sheet Metal Industries, November, 1939, Vol. 13. No. 151, p. 1361, 3 figs.*).

Practically all jobs can be triangulated from the elevation as drawn on a working drawing or blue print, as it is unnecessary to draw other elevation or plan views to enable true sections to be obtained, in their correct relation to each other. The deciding factor in determining a true length is the difference in the lengths of the projectors between points on the edges of the object and a vertical plane contiguous to it. The author gives then the rules by which the layout is drawn in actual practice for a ventilating connecting piece.

The Specification of Sheet for Deep Drawing and Pressing, by J. D. Jevons. (*Sheet Metal Industries, November, 1939, Vol. 13, No. 151, p. 1363*).

The purpose of specifications covering deep-drawing quality sheet is primarily and often solely to attempt to ensure that the fabricator obtains sheet which will withstand the shaping operations he intends to impose upon it. Properties specified. Grade or quality. Method of manufacture. Crystal size. Microstructure. Hardness. Directionality. For the purpose of specification, directionality could be controlled very readily by the simple tear length test, more precisely by tensile tests made in stated directions relative to that of rolling.

MANUFACTURING.

Interchangeability in Modern Aircraft Production, by C. Heriel. (*J.S.A.E. Vol. 45, No. 5, November, 1939, p. 15*). (*Digest*) (*72/52 U.S.A. 20985*).

With respect to aircraft mechanisms produced by conventional machine production methods, interchangeability is assured by tooling methods common to all industries. The author deals with the more complex parts of the structure, such as wing and fuselage, and the development of faired surfaces involving double curvatures. Such curves and out-lines are laid out full scale in a lofting department, but it is not practical for shop men to scale dimensions direct from such lofted outlines, as no two men would scale to the same identical dimension. Therefore, tables of offsets and bevels are prepared by the

lofting department to convert significant points on the moulded surface into numerical values useful to engineering and tooling personnel. With a structure as large as the wing, a system of applied analytical geometry is used to calculate any point on the wing structure, which is treated as a geometric solid.

Building Hurricane Fighters, by S. W. Hiscocks. (*Aircraft Production, December, 1939, Vol. I, No. 14, p. 472, 37 figs.*).

Quantity production of girder-type structures. How a large output is attained at the Hawker works. General arrangement and data of the Hawker Hurricane. Main planes. Jigs used for profiling the external form and lightening holes of nose rib blanks on Wadkin routing machines. Assembly of outer plane. Covering. Assembly of centre section. Ailerons and flaps. Tailplanes. Fin. Rudder and elevators. Fuselage. Assembly of the fuselage. General assembly. Detail shops. Building Hurricane fighters.

Brake Production. (*Automobile Engineer, September, 1939, Vol. XXIX, No. 388, p. 311, 13 figs.*).

Lack of standardisation between one vehicle and another introduces complications into production schedules and reduces the possibility for production economies. There are at present 250 types of brakes manufactured under commercial conditions by the Lockheed Hydraulic Brake Co. Ltd., at Leamington. Economical production of small quantities is not easy, and it is possible only if the tooling is simple and the machine setting up time low. Milling tandem master cylinders. Fine boring wheel cylinders. Multi-head radial drilling machine. Brake shoes and back plates. Riveting machine with hopper feed. Four-spindle automatic with gauge block. Hydraulic test on hose connections. Inertia test machine.

MATERIALS, MATERIAL TESTING.

Forging Aluminium Alloys, by George Sachs. (*Aircraft Production, December, 1939, Vol. I, No. 14, p. 489 25 figs.*).

Forged articles are generally regarded as having substantially better properties than cast ones, say 50 to 75% better, but great caution must sometimes be exercised in putting forward claims for them. Frequency of longitudinal and transverse strength in different alloys. The influence of the alloy. Relation of longitudinal to transverse tensile properties in different alloys. Secondary tensile stresses. Compression with different plates—flat, conical, concave. The forging of discs. Stress and strain in a forged disc. Increase of longitudinal strength in forging discs. Forged wheel. Decrease of transverse strength in forging discs. Impellers. Forging of bars. Stretching of a square bar. Rolling of a round bar. Mechanical properties of shaped forgings. Flash in forgings. Ribs in forgings. The stretching of forgings. Upsetting of a distressed rod head. Quenching stresses in solid and tubular rods. Correct quenching of propeller blades.

MECHANICS.

Dynamic Balancing, by J. Orwig Jones. (*Aircraft Production, December, 1939, Vol. I. No. 14, p. 484, 8 figs.*).

Theory of balancing. Effect of speed increase. Method of operation. Electrical operation. Wiring diagram for the E.O. type balancing machine. Production balancing.

The Determination of End-constraint of Struts by vibration Methods, by Hugh Alan Warren. (*The Journal of the Institution of Civil Engineers, November, 1939, No. 1, 1939-40, p. 49, 7 figs.*).

The theory concerning transverse vibrations of struts is modified and extended to conditions of elastic direction-constraint, and such theory is used as a basis for experimental work, demonstrating a means of evaluating elastic direction-constraint by measurement of the frequency of transverse vibrations when the axial load is known or can be measured. Further calculations concerning the harmonics of the fundamental mode of vibration indicate how the same purpose might be achieved without a knowledge of the axial load.

POWER, DRIVE.

Hydraulic Variable-speed Gear. (*Engineering, October 20, 1939, Vol. 148, No. 3849, p. 439*).

The new design of the " Sturm " variable oil drive is shown. This type of oil drive enables output speeds to be varied infinitely between minimum and maximum while under load. The drive has so far found its main field of employment in sizes from about three h.p. to 30 h.p. for the stepless variation of speeds at constant horse-power. The design of the drive lends itself to use with an electric motor either of the flanged or foot type, and push-button control can in such cases be applied for the simultaneous control of the pump and motor.

SMALL TOOLS.

The Design of Boring Bars, by P. G. (*Machinery, November 2, 1939, Vol. 55, No. 1412, p. 111, 8 figs.*).

The alternative of effecting adjustment after clamping is considered. Fine adjustment after clamping. Boring tool with expanding shank. Special keys for expanding and adjusting the tool shank. Expanding shank for blind holes. Gauge for the fine adjustment of the shank shown. Tool shank with micrometer adjustment (British precision diamond tools). Tool shank with micrometer adjustment, obtained by differential screw. Tool shank with micrometer adjustment which is held in a tapered hole in the boring bar. Tool with micrometer adjustment and expanding shank.

Changing from Solid to Ball-bearing Lineshafting, by M. P. Dalton. (*Power Transmission, November, 1939, Vol. 8, No. 94, p. 560*).

Among the advantages claimed for changing over from solid to ball bearing line shafting are : reduced maintenance, lower power consumption and increased speed. A change to ball bearing lineshaft reduced the idle load to less than 5% on each shaft replaced. First shafting ran at about 100 to 150 r.p.m. When ball bearings were to be installed speeds of about 300 to 500 r.p.m were taken, and this involved a shaft reduction to an average of $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. diameter. The pull on the belts, bearings and supports are reduced in direct proportion to the increase. Important savings by reducing the diameter of shafting and the size and strength of bearings and girder work, are the result. Smaller pulleys and shorter belts follow. If the speed is increased, all pulleys must be reduced to correspond. Ten years ago a $1\frac{1}{4}$ in. diameter shaft was erected in a woodworking shop to run at 750 r.p.m., and has done so without a hitch ever since. Once erected properly, good ball bearing shafting needs no maintenance beyond lubrication for at least three years. Shaft lengths must be

kept within the limits of temperature expansion allowed by the housing clearance. Girder expansion must receive equal consideration. An untrue shaft must not be tolerated. The overall saving on capital sunk in motors is also considerable.

Precision Diamond Tools. (*Automobile Engineer, September, 1939, Vol. XXIX, No. 388, p. 327, 3 figs.*).

Shape of cutting point. Handling of diamond tools. Adjustment of the tool edge. Recommended cutting speeds for precision turning and boring. Cooling.

STANDARDISATION.

Revision of British Standards for Whitworth Screw Threads, by C. le Maistre. (*Machinery, November 9, 1939, Vol. 55, No. 1413, p. 145*).

Standards for taps. Tolerance on effective diameter of screw threads. Tolerances on major and minor diameters of external threads. Tolerances of minor diameters of internal threads. Flattening of crests of external threads. Screw-thread gauges. Circulation of revised screw-thread tables for comment.

SURFACE TREATMENT.

Surface Finish. (*Automobile Engineer, November, 1939, Vol. XXIX, No. 390, p. 383, 7 figs.*).

Characteristics of different methods of removing metal. Type of finish, scratch depth (micro-inches), scratch pitch (inches), surface speed (feet per minute), feed (inch per minute), size change (inches), pressure (lbs.), heat generated (°F.), depth of surface ductility (inches). Honing has been described as the combination of four results in one process—surface character size and bore accuracy, desired degree of surface smoothness, efficient stock removing. Amount of metal to be removed by honing process. To remove metal with only slight generation of heat is of great importance. Pressure control is, therefore, of particular importance in honing operations. Some typical honing machines manufactured by the Barnes Drill Co., Rockford, Ill., U.S.A., are illustrated. Super-finish is an extremely fine surface finish produced by a combination of short motions, light abrasive pressures, slow abrasive cutting speeds, hard abrasive stones, and a lubricant of proper viscosity that eliminates the scratches and surface defects created by mechanical operations. Relation of work r.p.m. and stone reciporcation for various parts. Super-finish is extremely economical. It is seldom that more than thirty seconds processing is economically justified. Super-finishers are illustrated.

The Anodising of Aluminium, by "Anodiser." (*Machinery, November 9, 1939, Vol. 55, No. 1413, p. 137, 5 figs.*).

The process can be operated on an economic production basis in large or small units. Consideration of the subject can be conveniently divided as follows: (1) The fundamental basis; (2) the Bengough-Stuart process; (3) the Alumilite process; (4) the Eloxal process; (5) plant requirements; (6) properties of the anodic coating; (7) typical applications; (8) diagnosis of production troubles and their remedies, and (9) costs. Diagrams illustrating the process of electrolysis and the manner in which the oxide film is formed: (*a*) Commencement of film formation; (b) appearance after a short period; (c) film at the conclusion of the anodising period; (*d*) section showing three layers in the anodic of film, bloom, main body of oxide (porous), hard compact layer. Curves showing the relationship between current density and bath

temperature in the Bengough-Stuart process. Relationshp between time, applied voltage, and current density for the anodic oxidation of commercial aluminium by the standard Bengough-Stuart process, and by a special technique of a similar kind. Voltage/current-density curves for the Bengough Stuart process at 40°C. showing the effects of various representative allowing elements.

WELDING, BRAZING.

The Application of Oxy-acetylene Welding and Cutting to the Manufacture and Repair of Locomotives, by A. H. C. Page and G. Foster. (*The Welding Industry, November, 1939, Vol. VII, No. 10, p. 371, 21 figs.*).

Types of acetylene generators used. Types of welding and cutting equipment used. Oxy-acetylene cutting. Precision machine cutting. Examples of machine cutting : (1) Spring buckles ; (2) crank sweeps ; (3) quadrant links ; (4) radial track swing links ; (5) cutting for drop stamping ; (6) locomotive frames ; (7) miscellaneous locomotive details, oxy-acetylene cut.

Hand cutting : (1) Oxy-acetylene cutting in boiler repair shop ; (2) oxy-acetylene cutting in the steel foundry ; (3) demolition work ; (4) cutting on stripping pits.

Oxy-acetylene welding : (1) Sheet metal work ; (2) steel steam pipes ; (3) boiler tubes ; (4) super-heater elements ; (5) cast iron welding ; (6) " bronze " welding ; (7) bronze facing of steel ; (8) copper welding ; (9) aluminium welding ; (10) hard surfacing with the oxy-acetylene blow-pipe. The oxy-acetylene blow-pipes are invaluable in the building and repairing of locomotive stock.

A Critical Examination of Methods of Testing Welds, by J. M. Willey. (*The Welding Industry, November, 1939, Vol. VII, No. 10, p. 361, 15 figs.*).

The development of the application of welding to constructional work is largely dependent on the confidence inspired by welding, determined from precise knowledge of the properties of welded joints, which knowledge is a requisite for safe usuage. Determination of tensile strength. Undressed tensile test piece. Machined tensile test piece. Machine tensile test piece showing possible modes of fracture. Tensile test piece with holes drilled in order to locate fracture in the weld. Diagram of local elongations measured on a composite test specimen subjected to tension. Polar diagram of the local bend elongations measured on a composite bend test specimen. Measurement of ductility. Bend on a test specimen made of 25 tons per sq. in. plate and a weld of 33 tons per sq. in. Slight necking occurred in the plate at the bending zone. Portable hydraulic jack for workshop bend testing. Free bending tests. Bending of a test piece made of laminated plate. Cracks occurred in the parent metal at the bonding zone.

Welding Magnesium-alloy Sheet, by " Agricola." (*Sheet Metal Industries, November, 1939, Vol. 13, No. 151, p. 1375, 3 figs.*).

Properties of the magnesium-rich alloys. Table of chemical compositions of the wrought magnesium alloys. Table of mechanical properties of the wrought magnesium alloys compared with typical aluminium alloys. Oxidation. Type and preparation of the joint. Filler rods and flux. Correct size of welding rod for different sheet thickness. Sheet work. Welding technique. Details for the oxy-acetylene welding of the magnesium-rich alloys. Finishing treatment. Resistance welding. Quality of the welds. Testing the welds. Corrosion tests.